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# AVIATION

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# Veteran Guide
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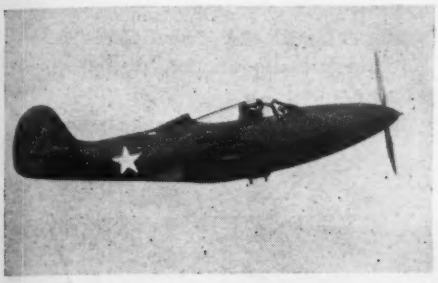
# In this Issue

ONE OF THE MOST comprehensive articles ever contained in a single issue of a trade publication is "Design Analysis of the Bell *Airacobra*" beginning on **page 126.** Arranged as a reference piece for the industry's engineers, the article breaks this outstanding combat airplane down by major subassemblies



and goes into the principal design and engineering details of each. In addition, fundamental design information, including dimensions, balance factors, and component weights, is presented in various tables. Structural arrangements of major sections are described with reference to materials, gages, and reasons for their selection. These descriptions are supported by some 70 illustrations including 42 line and perspective sketches.

THE ALCAN HIGHWAY is a great and dramatic achievement made possible by aviation. Prior to its actual construction it had long been an aerial pathway blazed by Canadian bush flyers plying their trade in the trackless Northwest. The part these intrepid pioneers played in providing the Allies with a military road of utmost strategic value is described on **page 114.**

THE SECOND of three articles on flight testing at Boeing Aircraft Company, appears on **page 118.** It was completed from notes and rough drafts prepared by Eddie Allen prior to his death. Men who worked with Mr. Allen and aided him in establishing flight testing on a business basis have completed his series of articles, just as they will carry to completion his notable flight testing plans.

WITH THE GREAT strides being made in horsepower available in multi-engine craft, a significant question arises in connection with propeller rotation to secure maximum performance. Opposite rotation seems to be definitely in the cards for the future. Whether propellers should rotate inboard or outboard is the question. A stimulating discussion of *which* it should be is on **page 156.**

MANY AIRCRAFT ENGINE plants are finding a wealth of electric power available for production work from engine test stands. The economics of generating electric power with aircraft engines and the physical set-up of this procedure is described in detail on **page 162.**

FOR SOME TIME RUBBER, as applied to metal forming, was considered a virtually perfect fluid. This is definitely not the case, and the efficiency of rubber pads varies according to location on the platen. Results of tests proving this variation in efficiency are given on **page 167.**

ESSENTIAL POINTS in making job analyses for good tool planning for quantity aircraft production are discussed in a concluding article on **page 179.**

MORE INFORMATION on the increasingly wide application of plastics to aircraft fabrication is contained in the second of a series of articles on **page 187.**

HOW BUICK has devised a way of fabricating tubing for aircraft engines to replace seamless tubing with more than satisfactory results is described on **page 199.**

IN THE TRANSPORT SECTION is a particularly valuable article on how, in the absence of radio directional beams, the ordinary direction finder can be used dependably for satisfactory instrument approach. This article is in two parts describing technique for varying conditions, and the first of this series begins on **page 224.**

IN CONNECTION with feeder airline problems, the industry and CAB face four major decisions in the development of this new and important postwar transport system. These problems and decisions are discussed on **page 227.**

HOW THE EMBRY-RIDDLE SCHOOL licked shortages of men, material and time to do the vast maintenance job required on Army training planes is described in "Setting Up the Engine Overhaul Station" on **page 231.**

A DETAILED DESCRIPTION of the methods and tools used in making heaters for DC-3's at American Airlines is given on **page 236.**

IN THE MILITARY SECTION is the second in a series of articles on development of gun turrets for military aircraft, with a series of sketches and detailed specifications on **page 247.**

THE STORY of a Lockheed modification center set up by Americans in England was cabled to us recently by our British correspondent and appears on **page 255.**

AVIATION'S CANADIAN CORRESPONDENT describes on **page 259** how the famed *Mosquito* bomber was designed to facilitate quantity production.

**Ralph S. Damon,** president of Republic Aviation Corp., who asks for a national aviation policy and that industry's counsel be taken in its formulation.

**I. M. Laddon,** executive vice-president of Consolidated Vultee Aircraft Corp., who describes how his company has reduced man-hours in producing aircraft, on page 170.

# *Dunco Quality*
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## WOMEN ARE UNDER FIRE, TOO!

An Ack-Ack barrage—even in miniature—is tough on a woman. Yet, some of the hard and brilliant work they are doing in industry *must* be done under fire.

American women deserve a home life, too. So now's the time to pitch in with everything we've got to whip the Axis. That is the spirit Solar relies on to produce adequate numbers of "anti-monoxide" exhaust manifolds for the fighting airplanes of the United Nations.

ARMY E NAVY

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EXHAUST SYSTEMS—

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# TRANSPORTATION—a vital war factor

## *The effectiveness of our armed forces and civilians alike depends on the efficiency of our transportation*

As the battle of Tunisia entered its final phases, with the British and American forces joining hands to crowd Rommel into his last fox hole, Hitler and Mussolini held their twelfth war-time meeting.

One important purpose of this meeting, according to the Berlin radio, was the study of a specially prepared "Survey of Continental Reserves". Topping this list of resources is the item of transportation.

Hitler has a great many headaches these days but, according to no less an authority than the Reich Ministry of Economics, "the central problem of the whole German war effort is transportation". It is, in fact, the Achilles' heel of Germany's War Machine.

The Nazis have become soberly conscious of its crucial importance and Mr. Hitler must wince when he recalls the gigantic miscalculations which led him to neglect his railways.

He counted on a short war, not a long wear-and-tear war and Germany's transportation crisis is getting more critical by the hour. It will play a vital part in its defeat.

This is a war of movement—on land, on sea and in the air. Russia's 2,000 mile battleline, R.A.F.'s 700 mile bombing raids, General Montgomery's 1,500 mile advance last November and the vast area that constitutes the theatre of war in the Pacific make this fairly obvious.

Peace will come when one side gets control over the world's supply of fuel, oil and rubber, for on these three critical materials depend all the vehicles of war—as well as of peace.

An army used to travel on its stomach. Today it travels on its fuel tank.

On the home front, transportation is no less vital. Here it is essential in getting the war workers, their raw materials and their products, to and from the mines, mills and factories that supply our armed forces and those of our Allies. Transportation is a major factor in the nation's ability to out-produce its enemies. Every known method, every type of vehicle becomes essential, for no single group of carriers, freight or passenger, can meet all our needs.

The railroads opened the vast resources of our nation and continue to be the backbone of our transportation system. Today they are doing the greatest job in their history. They are hauling more tons of freight more miles than ever before—33% more than in 1941 and 55% more than in 1918, peak year of the first World War. They are carrying more passengers more miles than ever before—80% more than in 1941 and 24% more than in 1918. They are getting more work out of each car, each engine, and each mile of track than ever before. Private operation of railroads is proving far more effective and efficient in this war than did government operation in the last war.

In contrast to Hitler's Germany, the managers of the American railroads have not neglected their plant except where government priorities forced them to do so. They are turning in an unprecedented performance despite the long starvation period to which they were subjected. During the first World War the total investment in the American railroad plant was about $18,600,000,000. Since then $12,000,000,000 have been spent on improvements and after deductions for scrapped facilities the net increase has been $8,000,000,000. Since the present war in Europe began the railroads have invested about $1,650,000,000 in further improvements, many of them to meet special war needs.

Convincing evidence of the railroads' flexibility in meeting the special needs of all-out war is their performance in coping with the movement of oil to the East Coast. In January 1942, one month following Pearl Harbor, the railroads delivered to the East Coast by tank car less than 100,000 barrels daily. By December they had stepped this up to more than 740,000 barrels and during the week ended April 3, 1943 they

*This is the eleventh of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers, and in daily newspapers in New York, Chicago and Washington, D. C. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.*

averaged more than 900,000 barrels per day. By the end of this year they are shooting for the goal of one million barrels a day.

Unlike Germany we have not attempted to control the development and growth of motor transportation according to the "intuitions" of one man but have wisely left it in the hands of experienced competition. That is how our highway transportation system came into being. Growing public acceptance has made it an essential part of our national economy.

The motor vehicle, its limitations set only by the improved highway and the supply of fuel and rubber, has developed to undreamed of proportions. Up to a year ago private automobiles consistently moved more people more miles than *all public carriers combined.* Buses have become an accepted means of mass transportation. Local electric and interurban railways in many cases were converted to bus lines and trucks took over the local freight services. Under these improved operating conditions traffic volume increased. When the war in the Pacific made it necessary for us to conserve our supply of rubber and the U-boat depredations in the Atlantic throttled the flow of gasoline to the eastern seaboard, our motor transport was forced to grapple with the toughest problem that ever had confronted it since it became so vital a factor in the every day transportation.

The "share-the-ride" idea recognizes the need of conserving gas, oil and rubber. This particularly applies to buses, for wherever groups can be assembled for a common destination, buses can be used most effectively. The intercity bus performs for the rural areas the same service that the local bus renders for the residential areas of our cities.

Reorganization of railroad schedules, adaptation of motor transport, rearrangement of working hours, all have contributed to provide a flexible transportation service for men and materials to meet the critical needs of the war effort. Twenty thousand intercity buses are handling 635 million passengers a year which is 69 per cent more than in 1941. The fact that these buses carry a relatively larger percentage of the total coach passenger business than their seating capacity would indicate suggests that here, too, we are getting a more efficient use of these vehicles in terms of passenger loads carried. It is fortunate to note that the geographic location of most intercity bus lines does not coincide with that of the railroads but rather supplements it.

The contribution which the urban transport industry is making to the war effort becomes apparent when we consider that buses, trolley buses and street cars today carry passengers at a rate which promises to exceed the impressive total of 21 billions, as compared with 18 billions in 1942 and an average of 13½ billions for the period 1936 to 1941. And this the industry is accomplishing with a minimum of added equipment and despite a serious drain on its manpower.

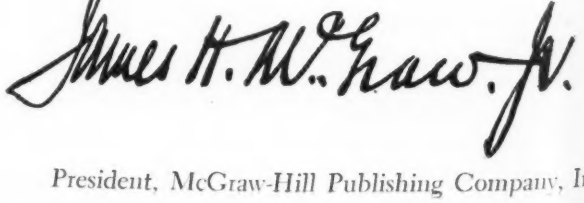
The truck lines, too, are setting all-time records. They have rearranged their schedules, eliminated circuitous routes and coordinated their services with those of other carriers. As this is written, contract truckers with the cooperation of the Office of Defense Transportation are trying to eliminate the empty return trip.

The transportation industry as a whole is face to face with the biggest job in its history. Increasing traffic loads, with little if any new equipment, difficulty in obtaining essential maintenance materials and a growing shortage of manpower, combine to make it that. While federal authorities, acting through the Office of Defense Transportation, took prompt cognizance of this condition, froze equipment and otherwise acted to conserve the vehicles then in service, it was not possible to add sufficient vehicles to keep pace with the increased traffic demand. However, the O.D.T. did lend impetus to the movement for staggering hours of work thereby spreading the peak loads and thus increasing the carrying power of existing fleets of vehicles in city service.

As we review the problems involved in meeting our transportation needs it is evident that we cannot depend upon new equipment alone for their solution. Lend-Lease is taking a considerable share of our much needed output of transportation equipment. The immediate job is up to the rank and file of the transportation industries. It is up to their resourcefulness and devotion to their job. The operating men out on the road, the men in the shops who keep the equipment going, who make the most of the metals and other materials they can have, who salvage, conserve and economize . . . these are the men who must bear the burden of our war load.

Theirs is a dramatic story, a story of cooperation and coordination . . . of ever increasing capacity on a shoestring allowance of new equipment.

For this is a war of movement. According to Joseph B. Eastman, Director of Defense Transportation, both the passenger and the freight traffic on the railroads is to a large extent war traffic – the transportation of troops and civilians on war business, the movement of food, raw materials and finished products required for the prosecution of the war. As Mr. Eastman put it, delayed arrival of troops at embarkation ports, delayed delivery of vital war materials could even conceivably mean the loss of men at the fighting front. And what Director Eastman says of the railroads applies to all forms of transportation. Transportation by bus, by street car, by truck, by train, by ship and by plane . . . all play a vital part in the achievement of victory . . . on the home front and on the fighting front which relies upon it.



*President, McGraw-Hill Publishing Company, Inc.*

# A Sermon in a Swan Song

FREEDOM FROM WANT is certainly a worthy objective, but it is exceedingly vague. Human beings will never be free from want no matter how much they possess. And this is fortunate, for complete freedom from want would be accompanied by freedom from incentive. And then we would not remain free from want very long.

But we are still far from this Utopian ideal.

Even now we are told that present food shortages in the most prosperous country in the world are due to the fact that the lower one-third of the population is now able to have enough to eat because of wartime wages and employment. It is shocking to realize that it required a major war to keep a large segment of our population from near-starvation.

It is both fitting and proper that we consider ways and means to provide the necessities of life and some of the luxuries of better living for our people after the war. But it is certain that we will not attain this objective by the destruction of individual initiative, as implied in the recent report of the National Resources Planning Board. The so-called partnerships between government and industry have been tried and found wanting. The nightmare of pre-war nationalization in France, which pushed airplane production down to a low of three planes per month, proved conclusively that government ownership is not only inefficient but unworkable. The records of our own experiments in government-operated plants also should be examined by advocates of these partnerships.

IF PRIVATE INDUSTRY had fallen down on its job in this war there might be some sense in changing the machinery of production. But industry has performed miracles and can do as well after the war if there is a demand for its wares. It is therefore obvious that corrective measures should be applied not to production but to distribution.

It is imperative that both government and industry give some thought to this problem now.

To criticize the recent report of the National Resources Planning Board may seem like beating a dead duck—but the duck is far from dead. It is only dormant. The idea of nationalized industry will rise again under some other name. In fact, it may appear to be a solution to the problem of relief for a few communities which are being built around plants which will have relatively little usefulness after the war. But this would only result in a superboondoggle which would make the WPA look like small-time business.

A substantial proportion of the facilities of the aviation manufacturing industry is now controlled by the government. With profits cut to the bone and no provision for postwar readjustment reserves in the contract renegotiations regulations, the industry would face grave handicaps after the war. It will neither be able to take over the government controlled facilities nor will it be able to develop new products to utilize these facilities.

IF WE ARE TO AVOID the totalitarian evils against which we are fighting, Congress must clear the way for industry to set aside funds for its own re-conversion. If this is done, as advocated wisely by the Truman Committee, the responsibility for the future of a great many people will be shifted squarely to the shoulders of industry.

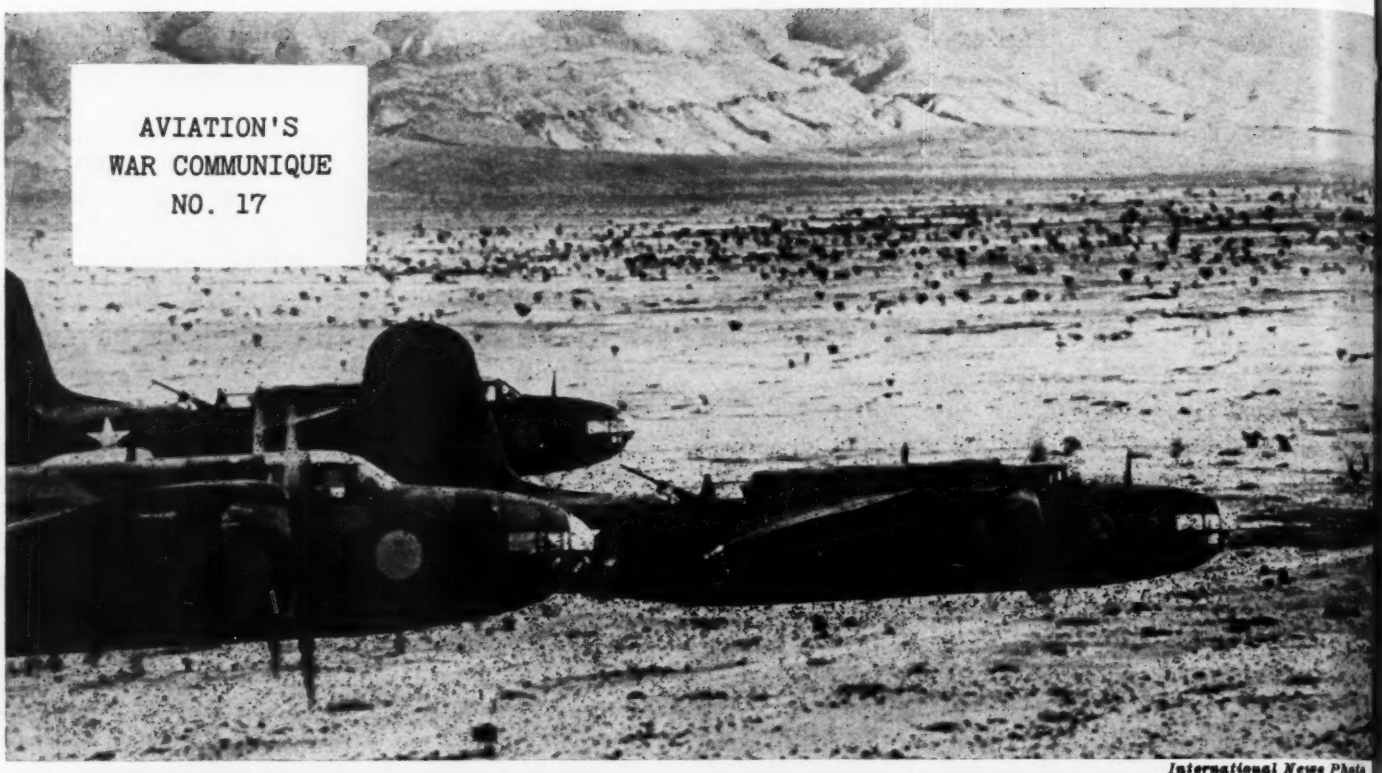
The responsibility of finding new products and wider markets is one that cannot and must not be shirked, because the masses of the people will not take kindly to the reappearance of breadlines. It is also unrealistic to assume that the workers will build up sufficient personal reserves to weather the adjustment period.

Industrial postwar planning under a system of private enterprise is a job in which each unit of the industry must work out its own salvation. The pride of some manufacturers may be hurt at thoughts of making such mundane products as metal window sashes, kitchen utensils, or prefabricated houses. Some may not adjust themselves easily to the unfamiliar fields of broad consumer market studies and merchandising. But if these ideas are distasteful, remember that the only insurance against the chaos of government ownership is to keep the workers working and to develop markets for the goods that they produce. What these goods are will be of secondary importance.

Leslie E. Neville

EDITOR.

AVIATION'S
WAR COMMUNIQUE
NO. 17



*International News Photo*

**Three desert-camouflaged AAF Douglas A-20's** skim Central Tunisian terrain in hurtling surprise attack on Axis positions at **Maknassy** and Mezzouna. Mission was completed with success, and planes returned safely to their base.

# America at War

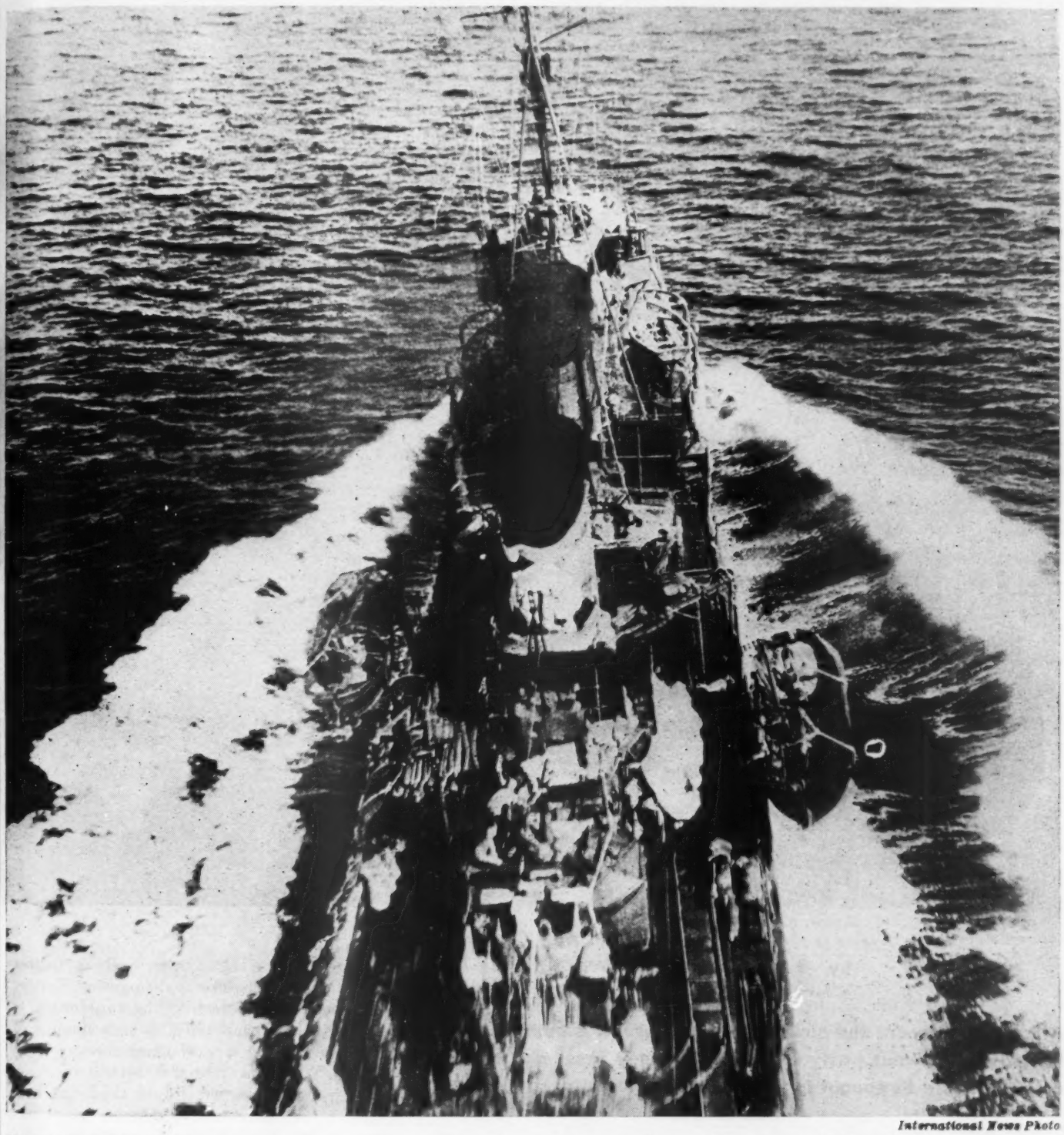
**Allies are now definitely on offensive, with air power spearheading all attacks . . . Axis commanders today face odds as iron fisted as those they ranged against Allies in early stages of war . . . Washington's green light to air generals sparks new multiple sky assaults.**

AMERICAN and British air power has reached great strength in England in preparation for assault on Nazi Europe. Maj. Gen. Ira C. Eaker, commander of the Britain-based United States Eighth Air Force, says that American military aviation on the European front is just now coming up to equality with the RAF. It is quite likely that British air power alone is now superior to the entire aviation of Germany. RAF strength available for air battling over invasion points will be equal to, or superior to, whatever aviation the Luftwaffe can muster away from the Russian front, and other places, to meet the onslaught. When the United States air forces virtually double those of England, the odds against Germany will be something like that which the French and the Poles and the British had to face when they were first attacked by the Nazis' dreadful *Stukas* and witch whistles.

Air attacks on German cities by the Allied forces are now double the worst the Nazis were able to throw at London, Plymouth, and Coventry. The damage looks tremendous in reconnaissance photographs, as it is bound to be, compared with damage done to English cities. Militarily, it should be worse because the Allies are trying to hit production plants, water fronts, and transportation centers.

But there is still very little visible evidence of weakness in the Nazis resulting from the air attack upon them. True, some shortages of supplies have been reported hindering them on the Russian front, but that might well be laid to transportation troubles not affected by Allied air attack. Men and munitions and supplies keep on coming against the Russians and against the British and Americans and French in Africa, and they flow to all the thousand and one Nazi strongholds throughout Europe.

Despite constant attacks on German submarine works, undersea boats are still produced in sufficient numbers to seriously slow our expansions in England and in Africa, and most authorities say they will get worse this summer. We are getting most of our ships through



*International News Photo*

**Intrepidly raking masts** of scurrying Jap destroyer in Bismarck Sea battle, land-based AAF bomber scored with this striking camera shot—as well as with bombs. Amidships, Nipponese seamen are ducking heads. Logs on decks were for landing operations.

and we are gaining weight against the enemy, yet our loss of life and property, with the prolongation of war, must continually mount.

But though the evidence of Nazi weakness as a result of air attack is very little, viewing the whole war on land, sea, and air, there are two pertinent points to be noted on our credit side. One is that the German air force appears to competent observers on the front to be growing weaker. The other point is that the whole gamut of Germany's production of tanks, guns, U-boats, supplies, and all, may have been curtailed and we wouldn't know it yet. Maybe these things are still coming out at the business end of the "pipeline" but are not going in as fast at the supply end.

When industry starts to pump weapons and food through supply channels toward the battle fronts, it takes a long time to fill the pipe. We ourselves have just learned this from experience. But maybe the process is now working in reverse for the Nazis, as their industry slows down under bombardment. A thousand units may still be coming out the front end, but perhaps only a comparative dozen are now going in at the supply end.

*(Turn to page 386)*

# WANTED—A National Aviation Policy*

By **RALPH S. DAMON**
*President, Republic Aviation Corporation*

**Aircraft producers and airline operators are, it is pointed out, entitled to know now what postwar regulation they face, and the industry's counsel should be sought in the rule-making.**

MANY PEOPLE have climbed out on limbs in the course of discussing postwar America and the postwar world generally. In fact, the trees today are so full that I find it difficult to secure a limb for myself.

In all of the current discussions of the postwar world, many of the subjects are naturally purely problematical, based upon suppositions which are military, geographical, political, and economic.

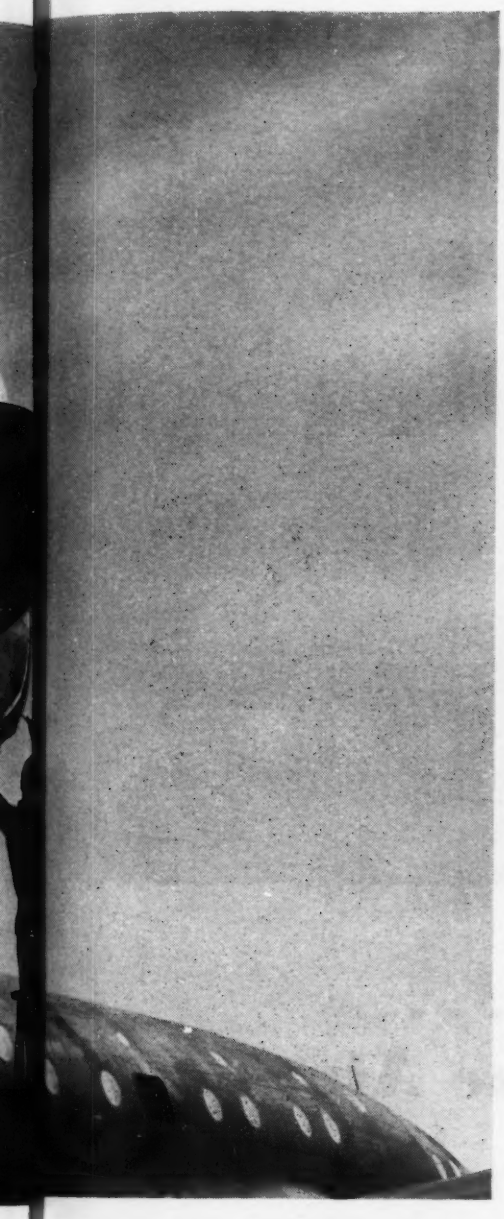
Devoting any time today to the topic of postwar activities and conditions invites a possibly justified criticism. There are those who will say, "Why so much postwar talk when we still have a war to win?" I agree fully that, although victory may be considered certain, there is much hard and long work to do and bad news to take, and that nothing must interfere with our winning of the war. I am assuming that with the proper dedication of ourselves to such hard work and bad news, the war will have been concluded by the end of 1944.

The ending will be due largely to the overwhelming preponderance of the aviation effort of the United Nations, which are now producing superior types of fighting planes in ever superior numbers. Currently we are out-producing the Axis in aircraft at the rate of three to one, and that ratio will be further increased before mid-summer. Combat box scores attest to the superiority of our airplanes and the high quality of the fighting men who man them.

With this victory there will come important basic changes in the living habits of this country, changes which will be produced by the development of the airplane in the course of this war. These basic changes may be as great or greater than those produced by the canal, railroad, automobile, or all of them put together.

The automobile, and the good roads program which made it possible, drastically revolutionized small town life. After this war, the airplane is going to change big city life just as drastically. And do something far more important—it will change small world life. What the good roads did for the automobile, the new military airfields will start to do for the airplane. We now have 25 times as many good airports as we had before the war. Many of them are in

* Excerpts from author's talk before the Sales Executives Club of New York.



remote places—but after this war those places won't be remote any more.

Not as an apology but as an explanation, it should be pointed out to those who have wondered why so much postwar talk before peace has come again, consideration of postwar problems and conditions is vitally necessary for the aviation industry at this time if we are going to prevent a repetition of the situation which existed from the close of the last war to 1939.

It should be remembered that there were too few men then in the high seats of our government capable of comprehending the potentialities of aviation. A full appreciation of those potentialities requires some faint semblance of imagination, and unfortunately imagination has never been one of the prime requisites of a politician.

Today, while aviation enjoys the blessing of being the fair-haired child of all the war industries, we in aviation are determined that there shall never again be a recurrence of the conditions which existed prior to 1939. We are not crying in our beer but are simply positive that if America is to have protection of air power, our aviation industry must never again be viewed with simply mild detachment.

It is shocking to recall, but it is a fact that for eight years prior to 1941 we did not even have Assistant Secretaries of War and Navy for Air. It sounds fantastic but it is true that early in 1939 some of the leading aircraft and engine companies were devoting much of their time and effort seeking new orders while they were just two steps ahead of the sheriff.

In retrospect, it is all very ironic. Here was the country which gave the world the airplane, and here were the world's greatest aeronautical engineers and production men—yet as a nation there was not the faintest trace of a national air program. For years it was possible to count on your fingers the men in Washington who had some conception of the military and commercial power of the airplane. That was the picture of the manufacturing side of aviation in 1939. It wasn't at all bright.

The picture of the other phase of aviation—transport—was better but still not good. Although we had the world's best equipment, transport development in this country presented a paradoxical and sorry picture. Our airlines, headed by capable executives and backed by good staffs, were being hamstrung by unimaginative men in Washington—men who refused to concede that a strong forward policy for aviation was necessary.

In 1938 Congress passed the Civil Aeronautics Act establishing the Civil Aeronautics Authority as an independent agency. As such it subsequently appeared to be making excellent progress until, by executive order, this agency was again subjugated to the same cabinet office from which it had been emancipated by the act of Congress. Since this subjugation, the Civil Aeronautics Board appears to have forgotten that by the act of Congress it was created to "foster and develop." Rather it has confined itself almost exclusively to the regulatory type of hamstringing regulations, which older and more respected agencies would hesitate to undertake.

### Anent Recapture

It would appear that the board, composed of gentlemen who, while personally estimable, are endeavoring to prove that a committee is a group of men who individually can do nothing but as a committee can decide that nothing can be done.

For example, orders were issued calling for recapture of essentially all the profits of individual airlines since the beginning of organization up to a given date, and while it is true that public indignation was so great that these orders have been modified so far as these particular recaptures are concerned, the board has never conceded its error in stating its principle in the first place.

Another order, issued as recently as March, requires a certain airline to cut its promotion expenditures by 64 percent. In other words, the board, instead of remembering the words of the Act which created it to "foster and develop," is endeavoring to become the mother-in-law to determine how many handkerchiefs you put in your pocket every morning.

### Must Discuss Postwar Plans

Perhaps an explanation of such rulings lies in the typical fact that the most recent presidential appointment to this board is a "lame duck" Senator who, it is reliably reported, had never been in an airplane—had never flown up to the time of his appointment. When such a man becomes a member of the regulatory body which can and has issued orders recapturing profits, and delves into details of expense we appear to be having the same difficulties as those of Shakespeare's time, to which he so ably referred as "insolence of office".

Because the cries of the aviation industry which have gone into the wilderness of Washington had not been answered, our airlines had, at the time we entered the war, only about 350 transport planes.

It is for these and many other reasons that we in aviation are determined that constructive plans for our industry's place in the postwar world must be discussed now as well as later when the world leaders prepare a peace treaty. Never again will American aviation strive to prosper on a confused air policy, since I believe that certain elements of the administration and the Army and Navy now are fully aware of the shortsightedness which was so rampant less than three years ago.

Again to those who would protest against continued discussion of the postwar era, I point out that certain basic plans must be made now by any aircraft company intending to survive the change-over from a war to peacetime operation. Unless this is done now, the time lag necessary for development and operation would be practically disastrous when viewed competition-wise.

It takes fully two years—frequently more—for the development of important type aircraft. This means that should our industry refrain from making any advance plans until the last enemy plane has been shot down, those who ordinarily use the airlines come

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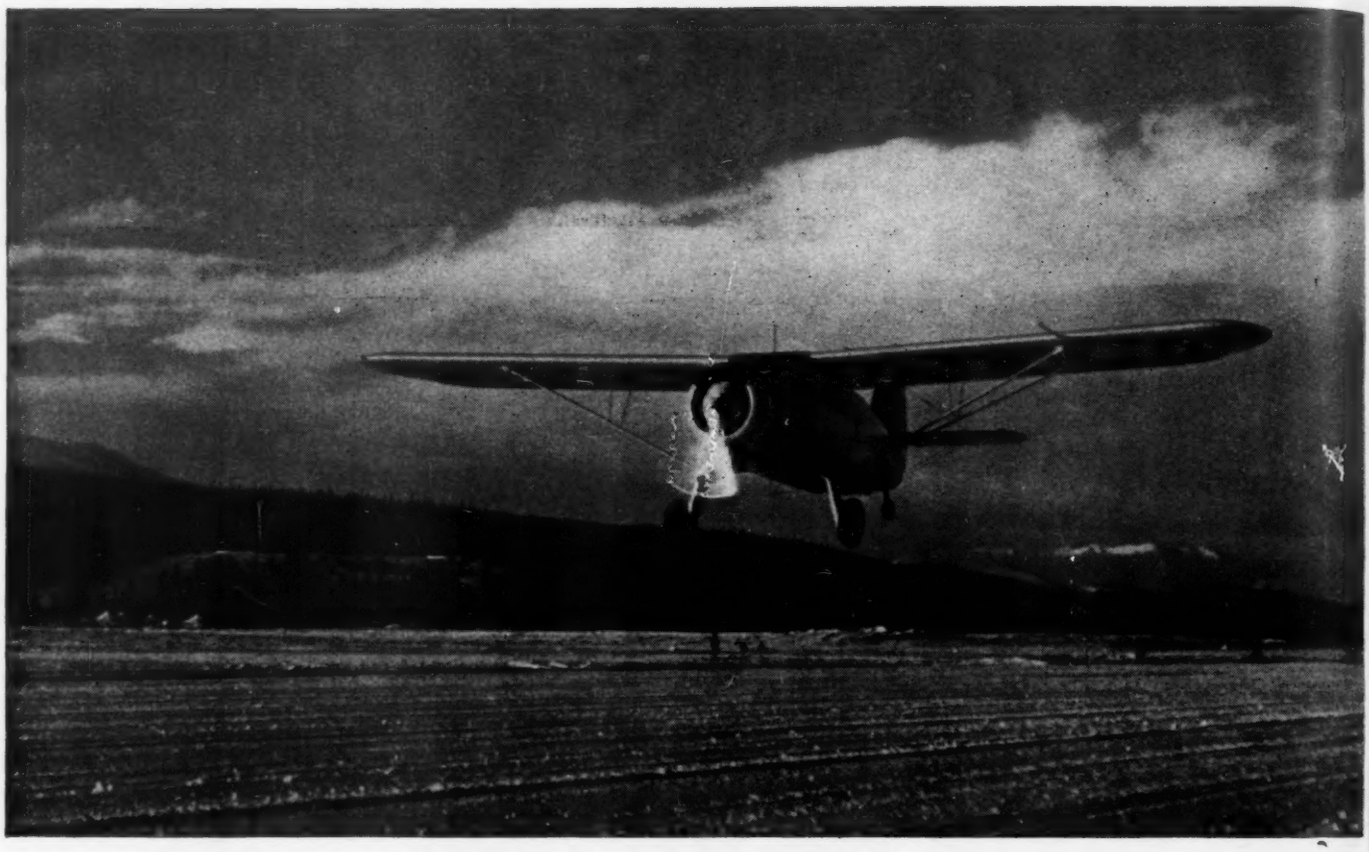


# Alcan Highway . . . Pioneered from the Air

By ESTHER H. FORBES

**A land route into Alaska, so long a vision in men's minds, has at last been realized, strategy of world conflict having supplied the impetus. And today the global potentialities of this project are too great to be forecast. But though it took this war to launch it, the highway was actually founded in 15 yr. of flying—as tellingly revealed here**

STRETCHING 1,600 MI. from Dawson Creek, Canada, to Fairbanks, Alaska, the Alcan Highway represents one of the greatest engineering feats in history. Begun hastily last February after Pearl Harbor had at last brought home to this country the strategic importance of Alaska, the highway was officially opened just nine months later, on November 20. Actually, the construction work was done in less than six months.

Yet the roots of the highway date back 15 yr. In 1928, Donald McDonald, an engineer of the Alaska Road Commission, began a fervent campaign for a highway to link the United States to Alaska, and he had been agitating persistently for one ever since. To prove that a road was practicable, he himself made extensive explorations along the mountains on the Pacific Coast.

Finally, in 1930, Pres. Hoover appointed a commission to make a reconnaissance study of a route from the State of Washington to Fairbanks, but when the commission made its report three years later and proposed negotiations with the Canadian authorities, it was ignored. In 1938 another American commission made further studies and tried to interest the military men of both countries in the proposal, but to no avail. Then suddenly the attack on Pearl Harbor brought a quick reopening of negotiations.

**Meanwhile, a quite different group of men had, unwittingly, been blazing the trail for the highway. These were the Canadian bush flyers of the '20's and '30's. By their pioneering flights into uncharted lands of Northwest Canada, followed by establishment of landing strips and later full-fledged airfields, they determined in outline the route of the Alcan Highway.**

Since its birth in 1919, when the Air Board Act was passed, Canadian commercial aviation has thrived on the transportation of air cargo to and from remote spots, inacessible except by air. Mining developments have been its life blood, and many of the large mining projects in northern Canada have, in turn, been made possible only by the airplane.

Commercial airplanes carried prospectors on the search for tungsten, mercury, radium, gold, and oil on long flights, over vast uninhabited regions, to stake out claims. They transported men and materials for the development of the newly discovered mines. And, finally, they carried the metals back to the railheads, which were usually hundreds of miles away.

It is quite natural, therefore, that the first flights into Canada's Northwest Territories should have been made as explorations for mining companies. In 1928, C. H. "Punch" Dickins, then a pilot for Western Canada Airways and now vice-president and general manager of Canadian Pacific Airlines, on a charter flight for a well-known mining executive piloted the first plane over the barren lands of the Northwest Territories, mapping large areas of these regions and charting air lanes over 4,000 mi. of wilderness never seen before.

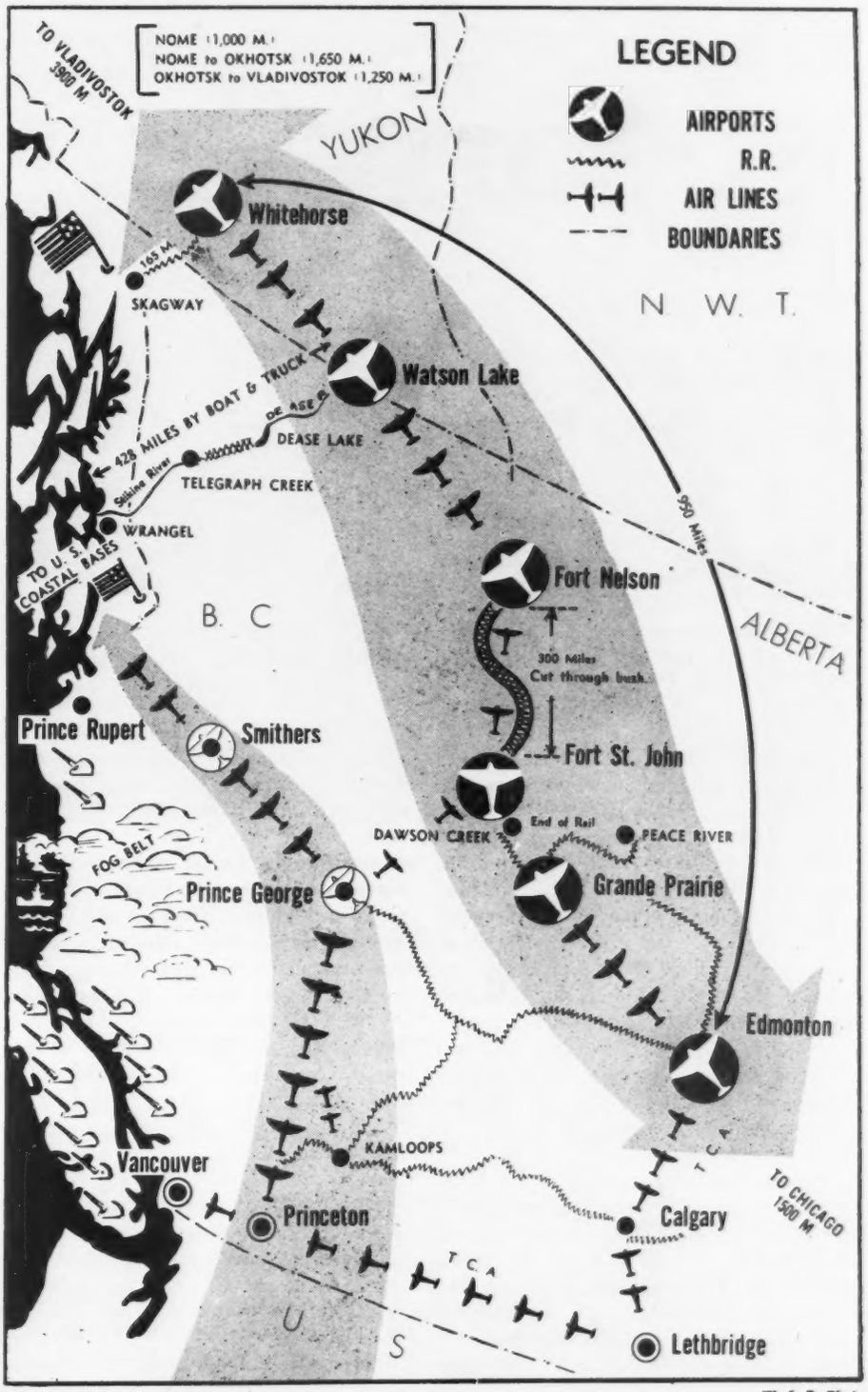
In 1930, Mr. Dickins flew the first prospectors to Great Bear Lake to what is now the United Nations' sole source of radium. And in 1935 he piloted the Canadian Deputy Minister of Mines on a 10,000-mi. survey of northern mineral lands. More recently other pioneers have carried other prospectors to new northern mining fields, one of which proved to be the richest mercury deposit in the British Empire.

Undaunted by the sub-zero weather of the northwest winters, these pioneers flew all year round, establishing air routes and services and then flying on to new lands. In summer they used floats and operated from lakes or from the many large rivers of the north. Then in winter they changed to skis and landed on the thickly frozen ice.

Where they found a particularly favorable stretch of water they would build a wharf and come back to it on their next trips. In addition, they cleared away landing strips for land planes in a number of remote areas. These landing strips proved priceless in the construction of the Alcan Highway.

Because the airplane was the only means of transportation in most of northern Canada, it had become a commonplace even by 1933, when flying was still not entirely accepted in the more populated districts to the south. The Eskimos, mechanically minded in the extreme, took to the airplane like ducks to water. Often, after watching a pilot tinker with an engine for only a few minutes, some of them would step right in and do what they could to help fix it, although they had never seen a plane before.

**C. F. "Punch" Dickens,** vice-president and general manager, Canadian Pacific Airlines. In 1928-'29, he blazed the trail to Great Bear Lake and Aklavik.

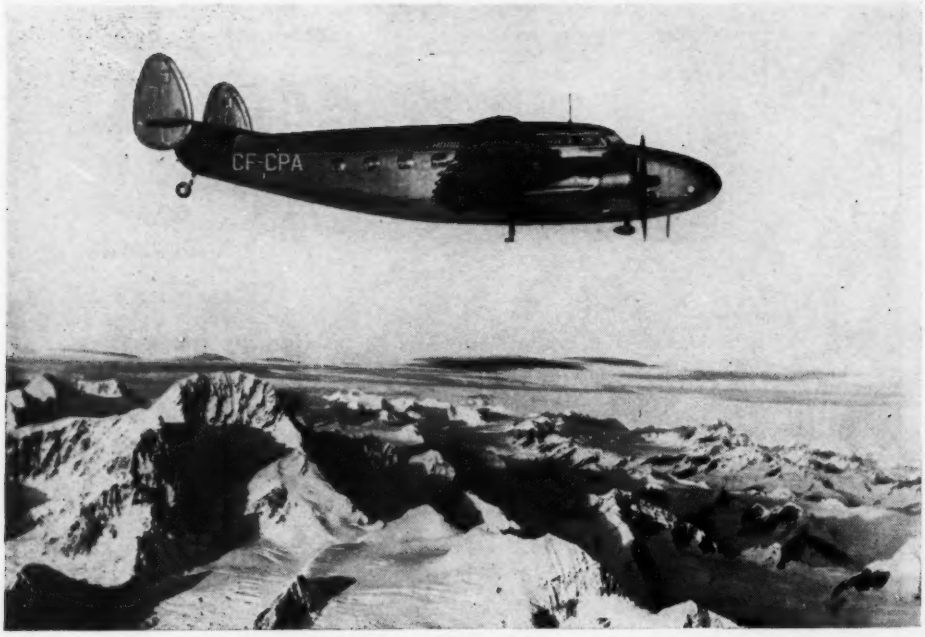



*W. I. B. Photo*

**These are the airfields on the road to Alaska.** Years of independent flying laid the foundations for the highway achievement, pulled the route in from the fog-ridden coastal belt and projected it closer to the heart of the two countries.

Assisting in mining developments was not the only activity of the early bush fliers, however. As early as 1927 Yukon Airways and Exploration Co. was operating a passenger and mail service between Whitehorse, Dawson, Mayo, and Keno, Yukon Territory, and another between Carcross, Y. T., and Atlin, British Columbia.

In 1929, Mr. Dickins flew across the Arctic Circle and on July 1 brought his plane down at Aklavik, a few hundred




**Twin-engine transports of Canadian Pacific** and Trans-Canada now ply between bases hacked out of wilderness all the way north to Alaska. Incidentally, Berlin is as close to Nome as to New York.

**Grant McConachie,** general manager, Western Div., Canadian Pacific Airlines. He started with one plane flying fish, later organized Yukon Southern Air Transport and planned airfields which freed planes from seasonal dependence on skis and floats.

miles south of the North Pole, thus becoming the first man to reach this Arctic Ocean seaport by air. As a result of the flight he received a mail contract a few months later to fly six times a year from McMurray, Alberta, to Aklavik. Even more important, he opened up the fur trade to air transport. Since then the airplane has practically replaced the dog sled and canoe in the delivery of furs to market.

In the late 20's planes were also beginning to fly fish, from the lakes of northern Alberta—to be served in Chicago restaurants within 48 hr. of the time they were caught.

Flying fish from one of these lakes was a young pilot who was to have a great influence on the development of aviation in Canada and on the building of the Alcan Highway—Grant McConachie. Starting with a one-man, one-plane airline in 1930, Mr. McConachie flew anywhere in northwest Canada that his plane was needed, and came to know and love the country. And the more he traveled over the beautiful northwest country, the more he realized its potentialities as an air "bridge" to Asia.

Accordingly, he set about to find the best route for the first lap of the bridge, from the Peace River region to the Yukon and Alaska. Backed by a mining prospector, he made charter flights to the Yukon during 1934 and 1935. At first he tried heading north from Prince Rupert along the coast of British Columbia but was forced inland by the prevailing fogs. Finding the flying conditions still poor, he explored the Finlay Valley further inland, but here, though the weather was good, the country offered no suitable landing places.

Again, he moved east and started flying from Fort St. John north to Fort Nelson, then west along the Valley of the Liard to Whitehorse. In 1937, Mr. McConachie inaugurated a regularly scheduled air mail and passenger service along this route from Edmonton, Alberta, to Whitehorse. By 1938, his company, reorganized as Yukon Southern Air Transport, was operating 13 planes into British Columbia and the Yukon.

Early in his career Mr. McConachie had learned the advantages of land planes, chief of which is their usefulness in all seasons, provided the fields can be kept clear. The ski-float planes which had performed such yeoman service in the preliminary pioneering have the disadvantage of being forced out of use for about six weeks during the spring thaws and for another six weeks during the freeze-up in the fall. As soon as possible, therefore, Mr. McConachie set to work building suitable landing fields. The first was established in 1938 at Fort St. John, with others soon following at Nelson and Watson Lake en route. In the spring of 1940, Yukon Southern abandoned floats and skis entirely and mounted wheels.

Because of these landing fields, which can be used the year round, Yukon Southern's route from Fort St. John to Whitehorse—and thence to Fairbanks via the route formerly surveyed and recommended by the American Commission—was the one finally chosen for the Alcan Highway. Our Army Ferry Command was already using the route

(*Turn to page* 401)

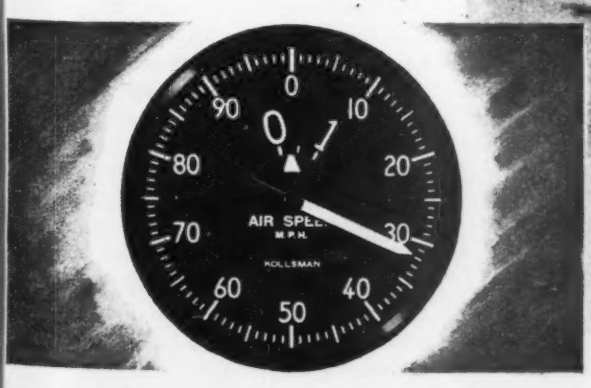
**Craft like this Fairchild 82,** along with Bellanca *Pacemakers* and *Airbuses*, Fairchild 71's and Noorduyn *Norsemen*, blazed the way for airfields and larger planes.

# "You can't fly a Beam to Dakar"

**"COMPARED TO THIS OCEAN-HOPPING,** flying a transport over the Blue Ridge was duck soup. All you did then was hang onto a beam. But, brother, it's different now. There aren't many signposts on the way to Africa except the dials on your instrument panel. And when there's nothing in sight but salt water, those dials are mighty comforting.

"After the war, I guess I'll be back behind the wheel of a passenger plane again but I'll probably still be flying by instruments . . . in the stratosphere . . . non-stop from coast-to-coast. Well — as long as I've got instruments I can depend on, I'll say that's the way to get there."

**WHAT TOMORROW'S PLANES** *will look like or how they will perform, we don't exactly know. But we do know that Kollsman research engineers are constantly planning and developing new and better precision aircraft instruments . . . to help smooth out tomorrow's skyways, and give safer wings to a nation at peace.*

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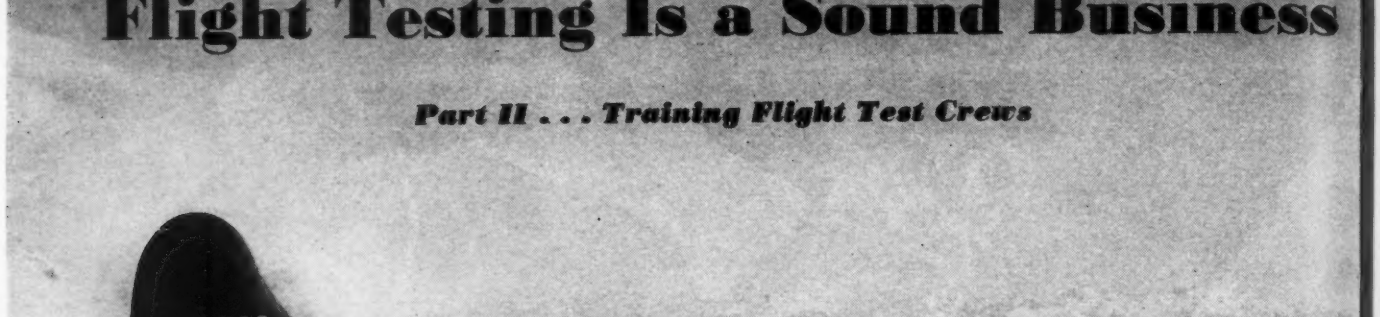
# Flight Testing Is a Sound Business

## *Part II . . . Training Flight Test Crews*



By EDMUND T. ALLEN

**Continuing the distinguished test pilot's significant three-part series, this second article deals with training systems and the equipment required for maintaining a flight test staff.**

IN THE NOT TOO DISTANT PAST, curricula at the many aeronautical schools were almost devoid of those subjects which would particularly fit a man for position of flight engineer or instrumentation engineer in a large flight test organization. Most of the attention, in the past, was devoted to aerodynamic subjects, with an adequate amount of wind tunnel technique and detailed design and layout work.

So for some time now aircraft companies have found it increasingly difficult to secure graduate aeronautical engineers. Even a graduate engineer requires an extensive training period to fit him for the job of a flight test engineer.

In 1941, realizing the shortage of men properly trained for this type of work, the Boeing Aircraft Co. initiated a survey among 18 colleges and 25 manufacturing concerns. This survey was partially successful and a cooperative program was worked out at that time which since has aided substantially in providing aircraft manufacturers with a few trained flight test engineers.

Meanwhile, it has been necessary for the flight and aerodynamics department to train the personnel required to conduct the extensive high altitude research program for the past three years.

Flight test crew training at Boeing is simple, direct, and to the point. It instills in the new men the basic principles of the organization (as outlined in Part I of this series, April AVIATION), discipline, self-reliance, self-control, safety and efficiency. Secondly, it results in attainment of a proficiency in specific procedure.

Before a new man is hired for a flight test crew, he is given a thorough physical check. The doctor making such an examination should be intimately conversant with the physiology of high altitude flying, flight crew maintenance methods, and the latest information regarding aeromedicine, which has been evolved in the comparative short space of time that high altitude flying has been practiced.

Having successfully passed a medical examination, the new crew member enters the first phase of training by attending an intensive two week course at Boeing's Engineering School. Operated under the auspices of the Engineering Division, the course is designed to familiarize new employees with the organizational scheme, engineering drafting procedures, and actual practice in drafting problems. Newly hired men for the regular Engineering Division continue this schooling for an additional two weeks. The flight test engineers leave, after the two-weeks indoctrination period, to attend the Boeing flight test engineering school.

Prior to the beginning of such classes, new men are given a tour of the entire manufacturing facilities of the plants, the operations centers, the wind tunnel facilities, model shop, and mock-ups, to familiarize them with some of the activities with which they may be concerned at a later time. It has been found that a general familiarity with the company must be obtained during the training period, because time may never be available for this later.

The flight test engineering school is designed primarily for junior flight

test engineers. The curricula, however, are sufficiently broad that junior instrumentation engineers, junior analysis engineers, even pilots and copilots, may profitably attend these classes. Primarily, the schooling is divided into sections, the first comprised of 15 lectures extending over a two week period. A detailed outline of the lecture subjects is presented herewith.

The general lectures are followed by seven full-day lectures dealing with the Boeing *Flying Fortress*, on which flight test research is conducted. This *Flynig Fortress* course includes actual practice in various operational procedures, familiarization with the kinds and varieties of equipment used for testing, and oral and written examinations. Instructors are men who currently serve in flight engineering capacities in the organization, making for ease of acquaintanceship between the experienced and the new personnel.

Aside from schooling new men on their duties in flight research, the indoctrination period includes a considerable amount of time devoted to safety procedures at high altitude. At the time the flight test department was organized, for the purpose of high altitude research, little was known about the stratosphere and the factors which limited man's actions in that region. Certain rules and regulations were laid down, and they are closely adhered to by all crew members. Each man must

(*Turn to page* 417)

**In this new low pressure test chamber,** student flight test crews are prepared for high altitude conditions as part of extensive training in this important research department. Chamber, which accommodates complete crew, can simulate a climb to over 50,000 ft. in four minutes, which makes possible study of aero-embolism, "diver's bends of air."

## Flight Engineer's Training Program

Lecture 1. *General Aspects of Flight Engineering*
- a. Company and departmental organization.
- b. Flight test—general.
- c. Test program survey.
- d. Future flight testing.
- e. Test airplanes.
- f. Flight test organization, flight engineering, etc.

Lecture 2. *Office Procedures*
- a. Emergency procedure (blackout, etc.).
- b. General procedure.
- c. Relevant stenographic procedure.
- d. Forms, etc.—general survey.
- e. Report and letter writing.
- f. Miscellaneous.

Lecture 3. *Flight Planning Procedure*
- a. Flight test procedure.
- b. Preparation of test plan.
  1. Details of various plans, significance of G. W., C. G., etc.
  2. Coordination of plans.
- c. Schedules.
- d. Conferences and notifications.
- e. Flight engineer checkoff list.
- f. Procedure: Flight engineer.

Lecture 4. *Flight Procedure*
- a. Preparation—data boards, sheets, etc.
- b. Locker assignment.
- c. Locker equipment and care of same.
- d. Pre-flight checkoff lists.
- e. Hangar procedure.
  1. Pre-flight, denitrogenation, etc.
  2. Post-flight.
- f. Flight duties and conduct.
  1. Use of interphone.
  2. Description of exits.
  3. Flight crew organization.
  4. Radio contact.
  5. Interceptor command.

Lecture 5. *Physiology of Respiration & Circulation*
- a. Respiratory system.
  1. General.
  2. Effect of altitude.
- b. Circulatory system.
  1. General.
  2. Effect of altitude.
- c. Crew training and maintenance.

Lecture 6 *Physiological Problems of Altitude & Oxygen Equipment*
- a. Afflictions of altitude.
- b. Oxygen equipment.
- c. Safety precautions in flight.
  1. General.
  2. Emergency procedures.

Lecture 7. *Miscellaneous Physiological Problems*
- a. Hyperventilation.
- b. Fear paralysis.
- c. Fatigue.
- d. Effect of accelerations.
- e. Miscellaneous.

Lecture 8. *Flight Test Information*
- a. Flight test documentation.
- b. Running flight test jobs.
  1. Log and alphabetical index.
  2. Bi-weekly Air Corps summary.
  3. Progress summary.
  4. Test program.
  5. Test item status.
  6. Information circular.
  7. Test item files.
  8. Flight time estimates.
- c. Weather.
- d. Flight test handbooks.
- e. Pilot's kits and map cases.

Lecture 9. *Elements of Aerodynamics*
- a. Aerodynamics.
- b. Application to flight test.
  1. Airspeed calibration.
  2. Flight polar.
  3. Climbs and glides.
  4. Stability.
  5. Stalls, takeoffs, and landings.
- c. Weather conditions for performance testing.
- d. Miscellaneous formulas—b.hp., etc.

Lecture 10. *Temperature Measurement*
- a. Theory of the potentiometer.
- b. Operation of the potentiometer.
- c. Operation of automatic temperature recorder.
- d. Data recording.
- e. Tolerances.
- f. Typical data.

Lecture 11. *Pressure Measurement*
- a. Theory of the manometer.
- b. Operation of equipment.
  1. Camera.
  2. Board.
- c. Data recording.
- d. Tolerances.
- e. Typical data.

Lecture 12. *Flight Analysis*
- a. General—Work of flight analyst group.
- b. Photo recorder.
- c. Reduction of data.
- d. Test aims.
- e. Miscellaneous.

Lecture 13. *Powerplants—Installation & Flight Test*
- a. Engine and accessories.
- b. Power measurement and power curves.
- c. Engine performance tests.
- d. Cooling tests.
- e. Functional tests.

Lectures 14 & 15. *Test Equipment*
- a. Installation and maintenance.
- b. Demonstration.

# Aviation's Postwar Portents

By H. L. FEDERMAN

ANY APPRAISAL of the aviation industry's postwar outlook must recognize the government as a key factor. Federal policies will dominate the course and future development of both the aircraft manufacturing and air transportation groups. More than the measures taken to implement any international role undertaken by our country are involved. Fact is that the actual status of the individual aviation units will be at stake.

The government—through the Defense Plant Corp., Reconstruction Finance Corp. subsidiary—has invested about $2,657,000,000 in 395 plants for the production and manufacture of airplanes, airplane engines, parts, instruments, and accessories. This amount exceeds by a wide margin the entire resources privately owned by the ten largest aircraft companies in the industry. And each of these ten units is a manufacturing giant capable of producing planes in substantial quantities.

### Presents a Challenge

The problem presents itself as to what will be done with these extensive aircraft properties owned by the government. This tremendous productive capacity will have considerable utility and it presents a challenge that can hardly be ignored.

Most of these aircraft facilities owned by Defense Plant Corp. and leased to private companies, carry a 90-day postwar purchase clause option. In other words, the aircraft units can, if they so desire, elect to purchase any plants under their operation at prices to be agreed upon. Outwardly, this appears to be a fair proposal, but the actual transition will most likely be more involved.

First of all, will the aircraft industry, in the postwar world, have a sufficient volume of business to occupy its presently-owned plants? Then, will the establishment of values to be paid for the government plants be a simple process?

And after these first two obstacles have been hurdled, where will the industry obtain the billions to finance these purchases?

It is evident that the process of unwinding the government's stake in the aircraft industry—and for that matter, in other industries as well—will be an intricate one. In this connection, it is difficult to overlook the implications that may be present in the *Security, Work, and Relief Policies* report recently issued by the National Resources Planning Board. Significant was the observation and recommendation that the government—

". . . . is already taking a considerable part in the management of the many war industries which have been greatly expanded by the use of government funds. Consideration should be given to the desirability of various types of partnership (supporting data unquestionably includes the aircraft industry—Editor). Government has a direct responsibility and should participate in the decisions as to what areas and what concerns should continue to operate in these industries."

This proposal of mixed partnerships—as part of a broad over-all economic program—will, if implemented, most certainly change the course of the aircraft industry.

In passing, it can be noted that while not a party to the NRPB report, the executive vice-president of Defense Plant Corp. is reported as a visitor at meetings held by the government planning agency. Obviously, this type of association is hardly conclusive, and in all fairness no positive assertions can be drawn that the DPC is in accord with the suggested program. But it is true that this key government agency is definitely aware of the proposals of the administration's potent planning group.

Most reassuring to those who believe in an independently-managed aircraft industry, were the remarks of Jesse Jones, chairman of Defense Plant Corp. In a particularly significant talk, Mr. Jones stated:

"International aviation will be one of our big problems. In the field of economies, and in the even more touchy relationship between nations, postwar aviation will be something we must face frankly and wisely. . . .

*"Private capital will have the opportunity of replacing government financing, and private initiative should take up where government leaves off."* (Italics ours.)

This statement from the chairman of the agency which will probably control the ultimate disposition of these government-owned plants, hardly denotes an era of a government-operated aircraft industry.

Ironically, the extensive participation of the government in aircraft plants, and the problems these commitments pose, represent an outgrowth of the policies pursued to solve the difficulties facing the aircraft builders in earlier days. It may be recalled that when the industry embarked upon its huge expansion program—primarily from 1939 through 1941—private capital could hardly be expected to supply all the necessary funds required. The major stumbling block was the risk involved. War-inspired expansion rarely has any sound permanent economic utility.

Hence, management and capital both looked to the government for the extraordinary financial support required to fulfill the scope of aircraft production demanded. With this aid, the industry has avoided the onerous burden of permanent plants and facilities whose utilization is of a temporary nature and thus allayed much of the suspended apprehension of the investing public.

### Property Accounts Decline

As a matter of fact, despite mounting production schedules, the actual net property investment accounts of many leading aircraft companies have actually started to decline. For example, the Glenn L. Martin Co., as of Dec. 31, 1942, shows a net property account of $6,958,497, which represents a reduction from the $7,480,542 reported a year earlier. Examination of comparative balance sheets for other companies discloses a similiar trend.

This is another manifestation of the constant strengthening of the financial structures of the aircraft builders. Through heavy depreciation and amortization charges, the plant investments are gradually being reduced. This merely means that the aircraft industry is constantly lessening the jeopardy of being burdened with excess manufacturing plant at the conclusion of

(*Turn to page* 400)

**POSTWAR CONTINGENCY RESERVES**

**Representative Aircraft Companies**

*(As of Dec. 31, 1942)*

| Company | Amount |
|---|---|
| Consolidated Aircraft Corp. | $4,000,000# |
| Glenn L. Martin Co. | 3,000,000 |
| Republic Aviation Corp. | 1,000,000 |
| United Aircraft Corp. | 23,897,271 |
| Vultee Aircraft, Inc. | 1,700,000# |

# As of Nov. 30, 1942.

**BARRON'S STOCK AVERAGES**

| | Aircrafts | Air Transports | 50 Stocks |
|---|---|---|---|
| Apr. 1, 1943 | 33.78* | 33.19 | 78 |
| Mar. 25, 1943 | 33.10 | 33.22* | 77 |
| Mar. 18, 1943 | 32.28 | 31.59 | 75 |
| Mar. 11, 1943 | 32.02 | 30.50 | 75 |
| Apr. 3, 1942 | 31.30 | 14.75 | 60 |

* New high for 1943.

# Factors and Flaws Of Contract Renegotiation

By RAYMOND L. HOADLEY
*Financial Editor, "Aviation"*

**Congress intends to "smack down" World War II war-profit ghosts before they can arise. But pointed questions are raised regarding renegotiation before excess profits taxes, impairment of reserves for the future, lack of a board of review, and of a true administrative "yardstick."**

On Feb. 16, 1943 the ghost of World War I walked again. On that day a decision was handed down by the Supreme Court in a suit instituted 20 yr. ago by the United States government to recover what it called "unconscionable" profits made back in 1918 by a company holding shipbuilding contracts. The company won—but it took those 20 yr. to get the final verdict.

This time Congress is determined to settle the business of war profits while the war is still on, instead of in 1963. Consequently, it adopted a policy of blanket and unlimited renegotiation of all war contracts just a year ago.

When this renegotiation law was enacted, no one knew—nor could they know—how the aircraft manufacturers would fare under such a broad statute which laid down no specific standards to go by. But it was realized that Uncle Sam had begun to take a double-barreled shot at stockholders earnings—i.e., the well known tax barrel and a new renegotiation barrel.

As a result of the protests that followed passage of this law, Congress modified it a bit last fall. And the four price adjustment boards set up to administer the act by the Army, Navy, Maritime Commission, and the Treasury, respectively, have recently issued a joint statement of policy.

### Effects of Control

Yet most of the aircraft industry still feels today that the act has its glaring defects. And only Congress can entirely remedy the situation, since it seems to be a case of a bad law, albeit ably administered in many respects.

Here are some of the baneful effects of such a sweeping discretionary control over wartime profits as many aircraft financial men see it:

First, the law calls for renegotiation of contracts *before* rather than after excess profits taxes. Such control seems superfluous to many observers when normal corporate income taxes and surtaxes take 40 percent of all earnings and the excess profits tax follows along to take 80 percent of surplus wartime earnings. Actually, some contend, renegotiation before taxes is simply a device for assisting the Treasury in the business of collecting taxes.

### Renegotiating Tips

If you are facing the complexities of renegotiation, says Author Hoadley, these procedure pointers may prove helpful—

- Do not argue the law or its constitutionality with the price adjustment boards. To hand down opinions and decisions of this nature is the role of Congress and courts, not of the government negotiators.
- Remember that the work of the accountant is auxiliary. Briefs should cover not only accounting facts but also business facts, such as inventive contributions, efficiency, economy of operation, speed of deliveries, use of patents, and risks undertaken to fill government contracts. And don't be modest.
- It does not help to bring along a political lawyer or a lawyer who has set himself up as a specialist in renegotiation when you come before a board. Board officials cite some instances where cases that could have been settled in 15 min. have taken four weeks or more with "lawyer-accompaniment"—with nothing beneficial accomplished by the political lawyer or specialist.

Annual reports of the war manufacturers show that, despite doubled and tripled production, stockholders are receiving less than they have in previous years before renegotiation.

Donald W. Douglas, president of Douglas Aircraft Co., which ranks prominently in value of war contracts, asserts that cost-plus-fixed-fee contracts with the Army and Navy are effective guarantees against war profiteering. This type of rigid, self-limiting contract, in addition to large increases in taxes, reduced Douglas profits nearly 40 percent in its first war year. The margin of profit was only 2.2 percent on total sales in 1942.

But there is even more strenuous objection over the fact that the price adjustment boards give little or no consideration to the aircraft industry's need to achieve a strong postwar position. Where do the boards stand on this question?

### Board's Viewpoint

One of the principles that govern these boards is that "a contractor's right to a reasonable profit and his need for working capital should be distinguished. A contractor should not be allowed to earn excess profits on war contracts merely because he lacks adequate working capital in relation to a greatly increased volume of business."

An aircraft official recently asked a high official on the Navy price adjustment board if his company would get any consideration in renegotiation for peacetime reserves, separation pay for its war employees, etc. The reply was that the boards "cannot take any official cognizance of these matters."

In fact the official attitude, believe it or not, towards postwar reserves is: (1) That the necessity for conversion may never arise; (2) that the nature, cost, and extent of conversion is too "conjectural" at this time; and (3) that the unknown duration of the war precludes any accurate estimate of the money that will be needed in the transition to peacetime products.

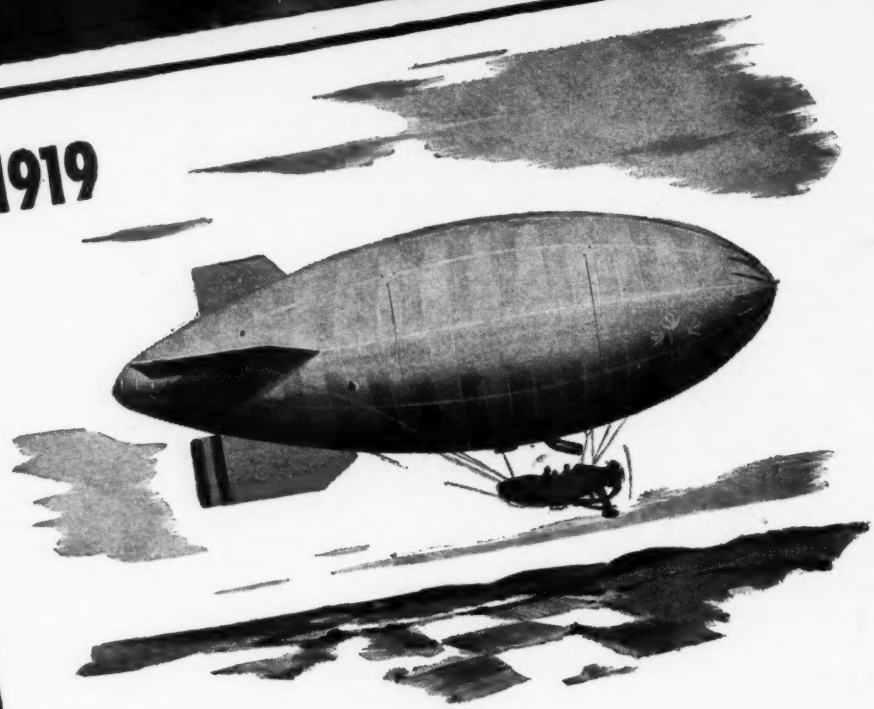
Yet it cannot be said that Army and Navy officials are entirely unaware of industry's postwar problems. Plans are reported under way to liberalize the termination clause of war contracts. These officials also expressed approval last year of the 10 percent postwar refund of excess profits taxes provided by the last Congress.

The heavy consumer goods industries

(*Turn to page* 398)

# *Trail Blazing in the Skies*

**1919**



**THE PIONEER COMMERCIAL AIRSHIP** in the United States was the "Pony Blimp," built by Goodyear in 1919 to demonstrate the possibilities of small lighter-than-air craft. Based at Los Angeles, it ferried passengers to Catalina, located and mapped deep-sea fishing grounds and was frequently employed in photographic work. This small ship of only 35,000 cubic-foot capacity provided much engineering and aeronautical knowledge that was later incorporated in the famous Goodyear blimp fleet.

**HOW GOODYEAR AIRCRAFT CORPORATION SERVES IN AERONAUTICS**

**1.** *By building parts to manufacturers' specifications.*

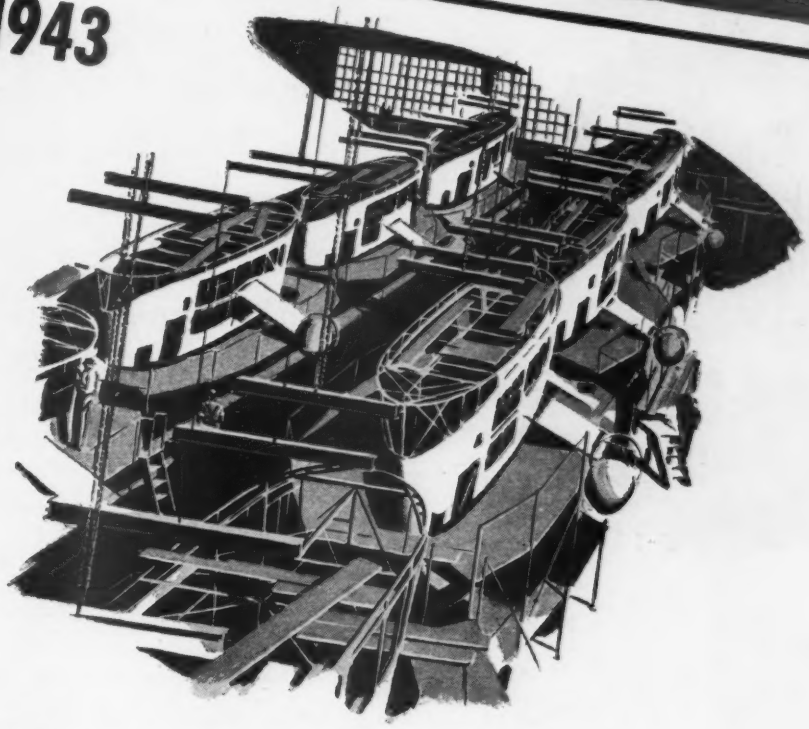
**2.** *By designing parts for all types of planes.*

**3.** *By re-engineering parts for mass production.*

**4.** *By extending our research facilities to aid the solution of any design or construction problem.*

**5.** *By building airships and airplanes for the government.*

# 1943

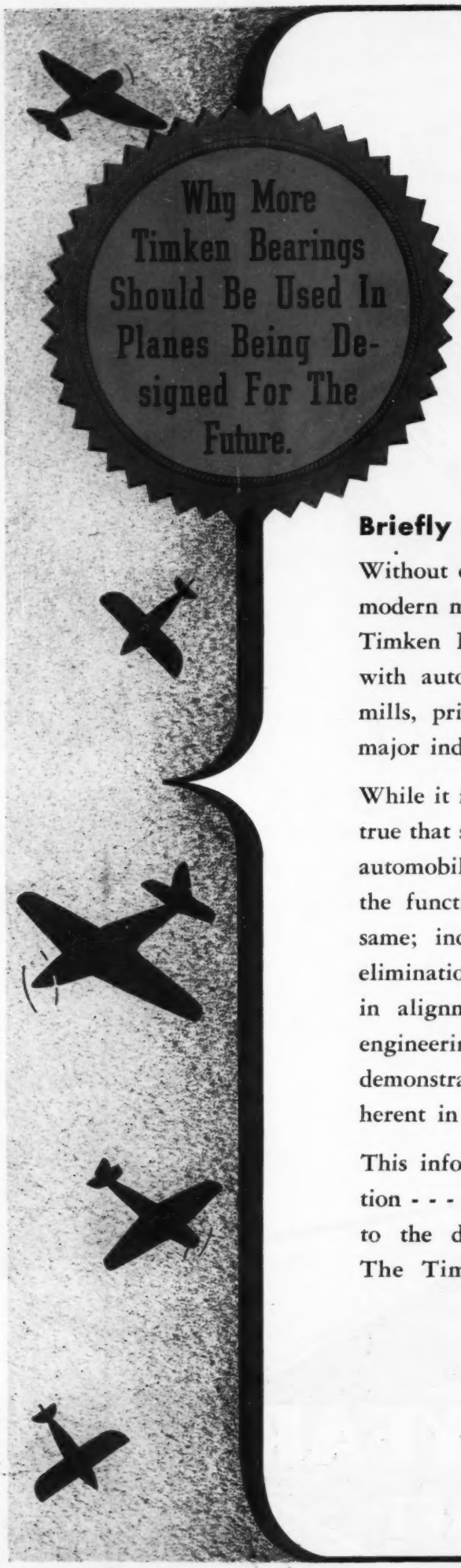


**THE WORLD'S FIRST AIRSHIP ASSEMBLY LINE** is operated today by Goodyear in building large submarine-patrol airships for the U. S. Navy. Here, by continuous mass-production methods, squadrons of sky cruisers are being speeded out in rapidly increasing numbers — the largest, fastest, farthest-ranging non-rigids the U. S. Navy has ever used. This high-speed construction is made possible only by Goodyear's quarter-century experience in airship fabrication — a "know how" that is proving invaluable today in guarding this nation's sea lanes.

GOODYEAR

GOODYEAR

AIRCRAFT



# Why More Timken Bearings Should Be Used In Planes Being Designed For The Future.

As wonderful as today's planes are the aviation industry is still in its infancy. Aviation engineers who are responsible for bearing selection, application and performance can profitably review the trend of the use of Timken Bearings from the early days of other industries until those industries grew into maturity.

**Briefly it is as follows:**

Without exception the number of Timken Bearings used in modern models or equipment is several times the number of Timken Bearings used when first applied. This happened with automobiles, trucks, tractors, farm implements, paper mills, printing presses, machine tools — in fact, nearly 50 major industries.

While it is true the aviation industry is "different", it is also true that steel mills are different from machine tools, and that automobiles are different from printing presses. Moreover, the functions of Timken Bearings in any industry are the same; included are load carrying both radial and thrust, elimination of friction, the holding of shafts, gears and wheels in alignment. Furthermore, the Timken Bearing and the engineering-manufacturing facilities behind it have amply demonstrated their ability to meet the special conditions inherent in every industry.

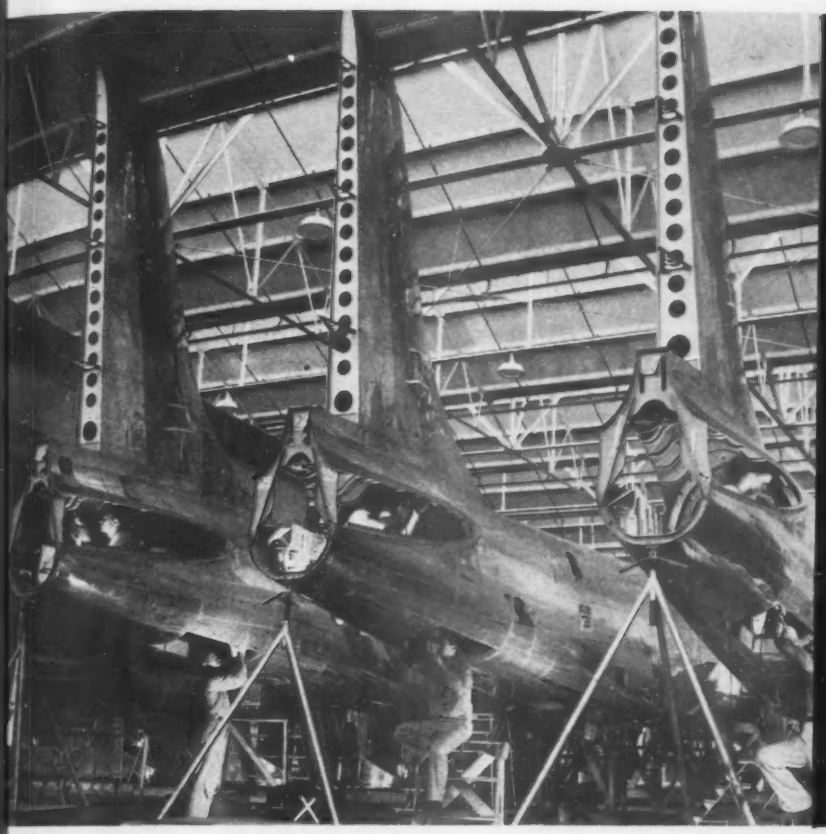
This information is worthy of your most earnest consideration - - - and, your conclusions can be profitably applied to the designs you contemplate building in the future. The Timken Roller Bearing Company, Canton, Ohio.

"ALL THERE IS IN BEARINGS"

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



# Manufacturing Section of AVIATION

PRODUCTION • DESIGN
RESEARCH
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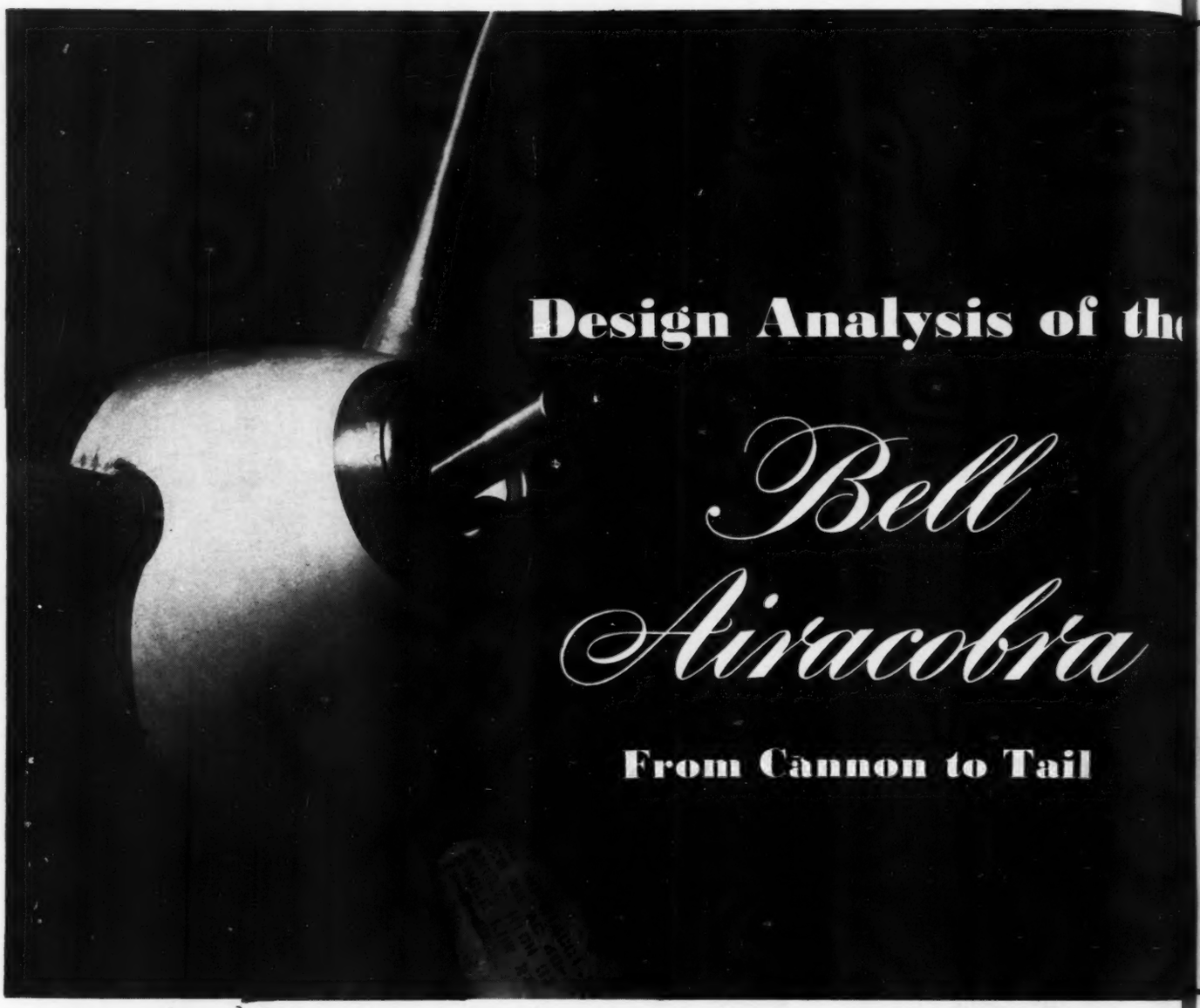


# Design Analysis of the Bell Airacobra

## From Cannon to Tail

By E. EUGENE MILLER
*Managing Editor, "Aviation"*

**Here is the first part-by-part study of a leading American warplane, revealing hitherto undisclosed technical details of the famous P-39 fighter and arranged for engineering reference.**

"WE WENT BACK TO FUNDAMENTALS!" said Larry Bell in his article in the July, 1941, AVIATION, describing the design philosophy of the Bell P-39 *Airacobra*.

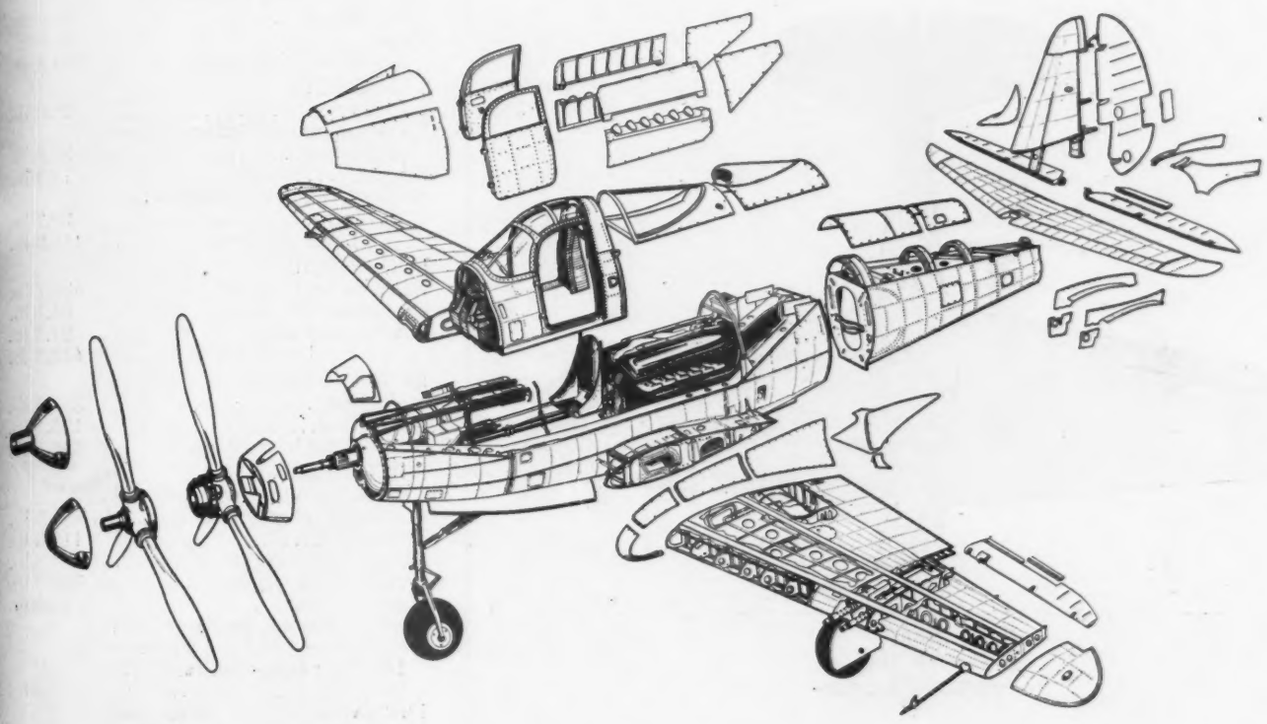
The fundamentals were first, firepower; second, good pilot visibility; and third, good landing and ground characteristics. And these engineering objectives were to be over and beyond ordinary fighter characteristics such as speed, maneuverability, and pilot protection—built into the *Airacobra* as a matter of fundamental "fundamentals".

The "over and beyond" were achieved in a single engineering stroke, i.e., locating the engine behind the pilot and transmitting its power through a drive shaft to a propeller gear box in the nose. Result: Firepower to spare! A 37-mm. cannon installation and two .50-cal. machine guns *in the nose* in addition to multiple wing gun installations. Anti-tank, anti-bomber, anti-ground transport, anti-*shipping* armament! Anti-fighter?—the record says it's tops!

Visibility is excellent. With engine behind and below his head level, the pilot can see in all directions with a minimum of obstruction.

The answer to safe high-speed landings and improved ground handling characteristics is a tricycle landing gear. To date, no one has engineered a retracting nose wheel into an engine compartment. This may not be impossible, but it was not necessary in the *Airacobra* with the engine out of the way.

The remote drive installation is the most obvious design characteristic of the *Airacobra*. But Larry Bell, Bob Woods, chief design engineer, and Harland M. Poyer, director of engineering, have not mustered theirs' and their staffs' brilliant talents to rest on this



**Exploded view of the Airacobra** showing major components. A Curtiss Electric or Aeroproducts propeller is used on various models.

achievement alone. The *Airacobra* is an outstanding design and engineering achievement from stem to stern. One way to demonstrate this is to take it apart and look it over.

## Fuselage

The fuselage is comprised of two spliced sections known as the "forward" and "aft" fuselages.

The forward section is the structural focal point of the *Airacobra* and where its design philosophy takes concrete shape.

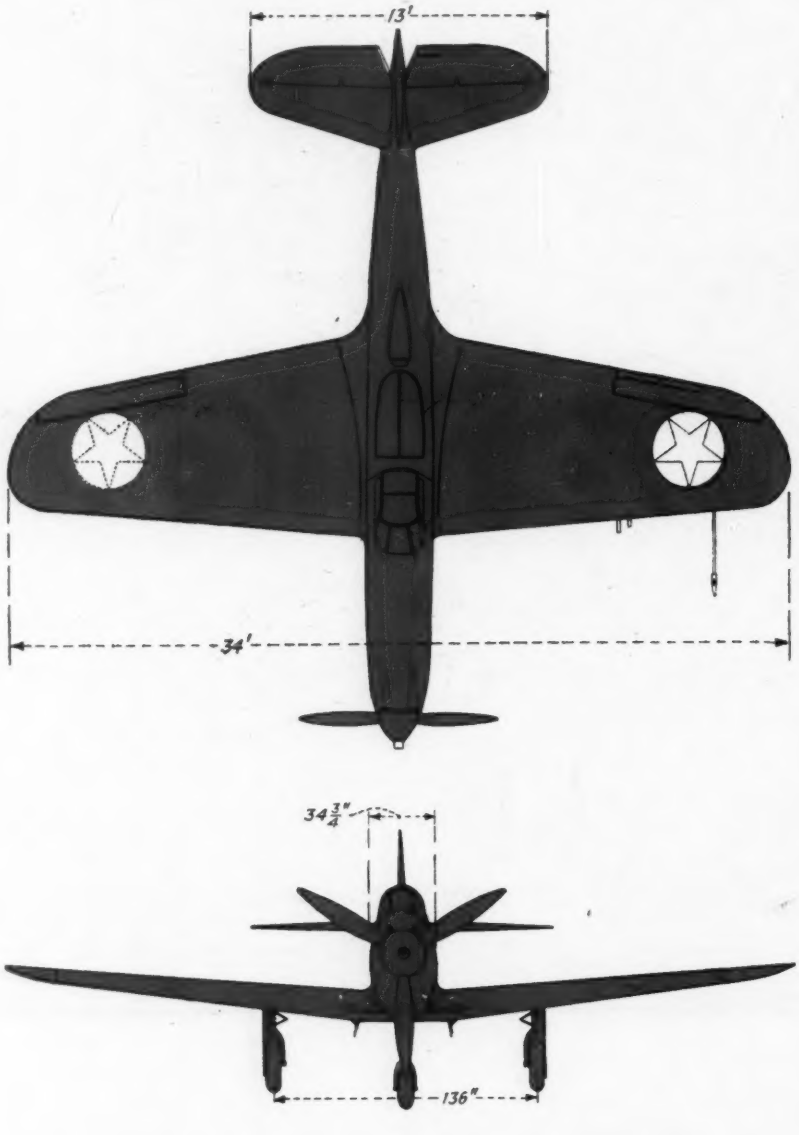
Integrally it comprises the major portion of the whole fuselage and contains the center wing section, engine bed, extension shaft and propeller gear reduction assembly mounts, principal armament mounts, nose wheel attachment fittings, and supports and brackets for myriad engine accessories—fuel, lubricating, oxygen, ventilating, control, electrical and hydraulic assemblies. To it are fastened the outer wings, pilot's cabin, engine and accessories, extension shaft and reduction gear box, heavier armament and ammunition magazines, oil and Prestone cooling systems, nose wheel assembly, and aft fuselage.

**Lawrence D. Bell, President of the Bell Aircraft Corp.**

A section of such impressive function must be of rugged, multi-purpose construction. It consists principally of two built-up longitudinal beams which are cradle shape in profile. Each beam is made of extruded aluminum alloy angle sections tied with virtually solid, heavily reinforced aluminum webbing. Outboard shape is imparted through a series of formed aluminum bulkheads. However, two of these bulkheads, located where the center wing section is tied in, are steel castings and become an integral part of this wing section.

A heavy gage aluminum, stamped deck plate is riveted to the tops of these bulkheads and extends the full length of the beam. To the rear of the beam a sturdy forged angle member is mounted to form the engine bed.

The outer skin of the forward fuselage consists of formed aluminum sheet riveted to the bulkheads. Skin panels in the nose section and beneath the pilot's cabin are .051 gage, and the rear panels are .032-gage sheet.




### Fundamental Design Information

| | | | |
|---|---|---|---|
| Overall length (max.) | 30 ft. 2 in. | Length root chord | 98.6 in. |
| Height (max.) | 9 ft. 3¼ in. | Length tip chord | 50.0 in. |
| Span | 34 ft. | Fuselage depth (max.) | 70.66 in. |
| Thickness root chord | 14.75 in. | Fuselage width | 34.75 in. |
| Thickness tip chord | 4.5 in. | Load factor — ultimate | 12 |
| Wing area (net) | 197.7 sq. ft. | Design gross weight | 7496 lb. |
| Taper ratio (root chord/tip chord) | 1.97:1 | | |

### Design Weights

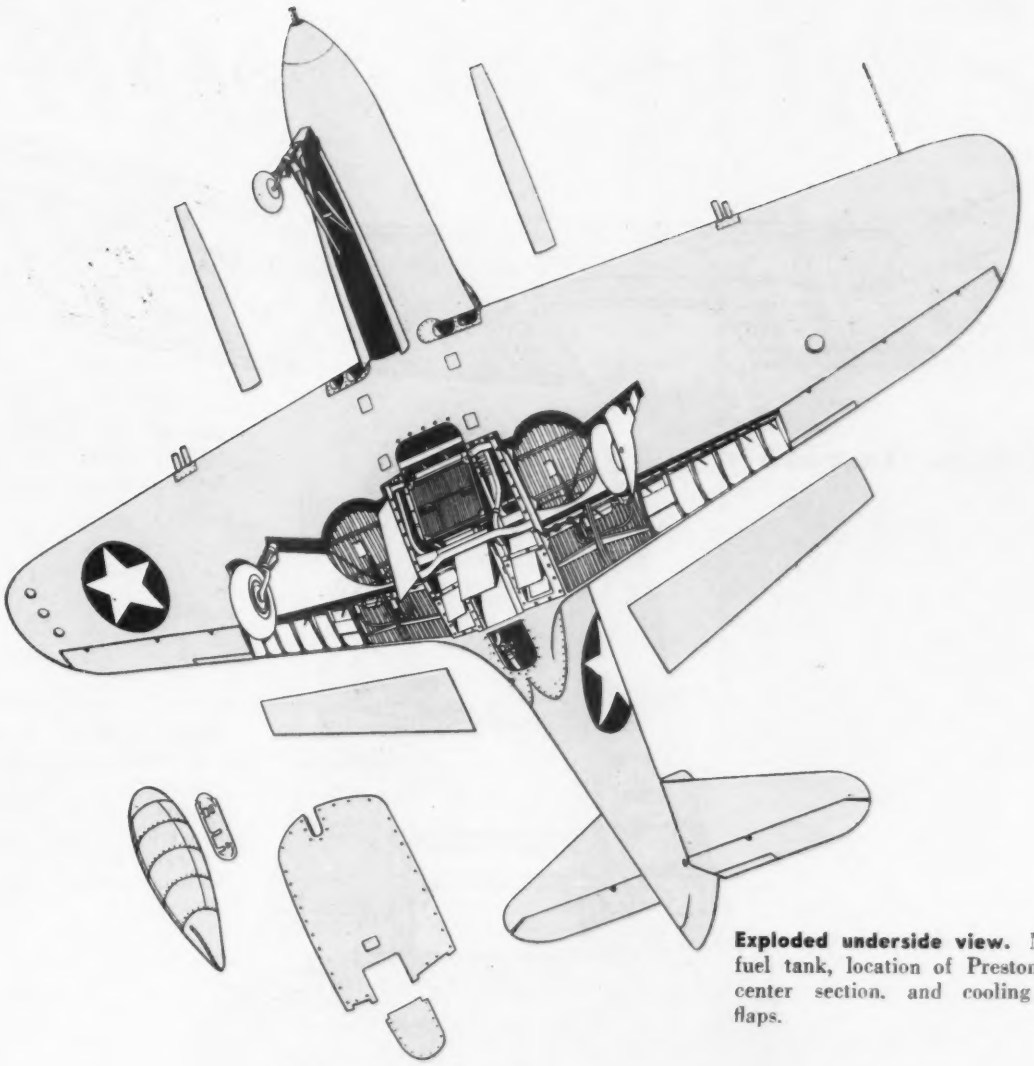
| | |
|---|---|
| **WING GROUP** | |
| Center section | 176.9 lb. |
| Outer panel | 675.7 lb. |
| Wing tips | 20.0 lb. |
| Ailerons (counter balance wt.—15.7 lb.) | 36.0 lb. |
| Flaps | 26.0 lb. |
| **Total wing group** | **934.6 lb.** |
| **TAIL GROUP** | |
| Stabilizer | 46.0 lb. |
| Elevators (counter balance wt.—12.2 lb.) | 33.0 lb. |
| Fin | 14.3 lb. |
| Rudder (counter balance wt.—10.1 lb.) | 22.7 lb. |
| **Total tail group** | **116.0 lb.** |
| **BODY GROUP** | |
| Fuselage (less engine) | 438.7 lb. |
| Enclosures and doors | 88.1 lb. |
| Cowling and fillets | 91.5 lb. |
| **Total body group** | **618.3 lb.** |
| **LANDING GEAR** | |
| Main gear | 391.5 lb. |
| Nose wheel | 125.1 lb. |
| **Total landing gear** | **516.6 lb.** |
| **POWER PLANT** | |
| Engine (including gear box and extension shaft) | 1,408.5 lb. |
| Accessories | 115.6 lb. |
| Power plant controls | 30.3 lb. |
| Propeller and spinner | 398.0 lb. |
| Starting system | 43.6 lb. |
| Cooling system (radiator and shutters — 156.0 lb.; liquid — 149.0 lb.; expansion tank 17.0 lb.) | 322.0 lb. |
| Lubricating system (tanks and supports — 13.0 lb.; piping, ducts, and shutters — 43.2 lb.) | 56.2 lb. |
| Fuel system tanks and protection — 240.0 lb.; piping — 49.2 lb.) | 289.2 lb. |
| **Total power plant** | **2,663.4 lb.** |
| **FIXED EQUIPMENT** | |
| Instruments | 60.3 lb. |
| Surface controls | 108.0 lb. |
| Electrical | 225.2 lb. |
| Communicating | 62.0 lb. |
| Armament provisions | 177.2 lb. |
| Furnishings | 41.6 lb. |
| **Total fixed equipment** | **674.3 lb.** |
| **Total empty weight** | **5,523.2 lb.** |

### Useful Load

| | |
|---|---|
| Crew | 160.0 lb. |
| Fuel tank (104 gal.) | 624.0 lb. |
| Oil tank (7.4 gal.) | 55.5 lb. |
| Oil for reduction gear box (2 gal.) | 15.0 lb. |
| .50-cal. machine gun installation. | 161.0 lb. |
| .50-cal. ammunition (400 rounds) | 129.0 lb. |
| .30-cal. machine gun installation. | 92.8 lb. |
| .30-cal. ammunition (1,200 rounds) | 78.0 lb. |
| 37-mm. cannon | 238.4 lb. |
| 37-mm. ammunition (30 rounds) | 60.0 lb. |
| Gun sights | 4.4 lb. |
| Armor plate | 202.5 lb. |
| Armor glass | 59.7 lb. |
| **Total useful load** | **1,880.3 lb.** |
| **Total airplane weight with useful load** | **7,403.5 lb.** |

### Unit Weights

| | |
|---|---|
| Wing group (213.2 sq. ft.) | 4.38 lb. per sq. ft. |
| Tail group (60.2 sq. ft.) | 1.93 lb. per sq. ft. |
| Weight of cooling system per normal horsepower (1150 hp.) | 0.28 lb. per hp. |
| Weight of lubricating system per gal. oil (13.8 gal.) | 4.07 lb. per gal. |
| Weight of fuel system per gal. (120 gal.) | 2.41 lb. per gal. |



**Exploded underside view.** Note auxiliary fuel tank, location of Prestone radiator in center section, and cooling air exhaust flaps.

The two main longitudinal beams are maintained rigidly parallel as a self contained unit, principally by tubular spreader bars, a forward bulkhead and former member, and the aft splicing bulkhead. However, the center wing section, coolant radiator supports, and pilot cabin which is joined later, also act as tying members.

The pilot cabin is superimposed on the forward fuselage but is designed and attached as an integral part of the fuselage just forward of the engine compartment. Fume-tight bulkheads are provided between the engine compartment and pilot cabin and between the cabin and armament compartment forward.

### Aft Fuselage

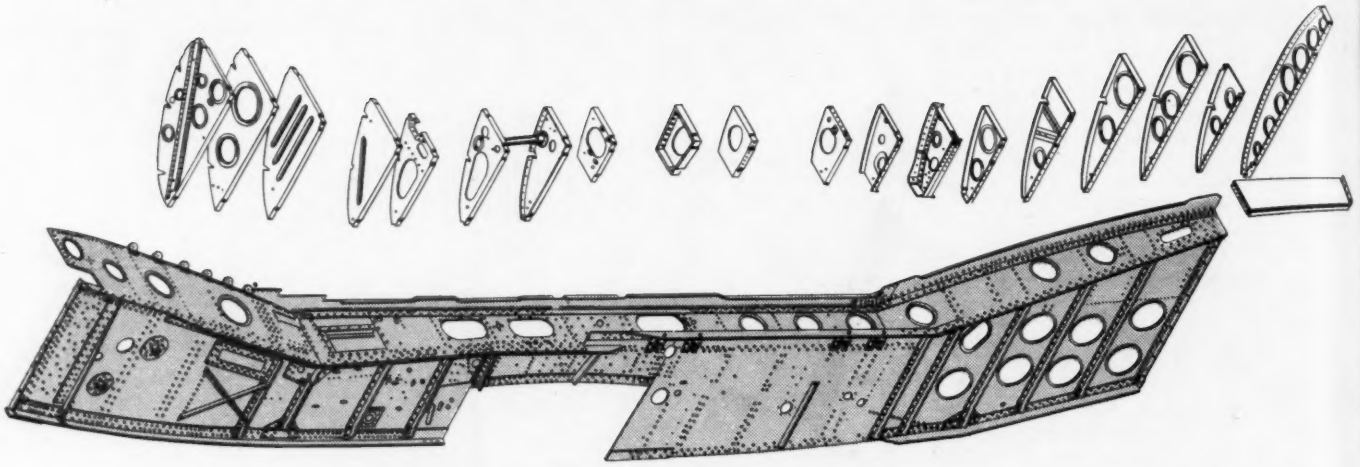
The aft fuselage section supports the complete empennage assembly and contains the radio installation. It is of ordinary semi-monocoque construction with eight principal forming bulkheads. The splicing bulkhead has a beaded sheet web and a number of drilled stiffeners for bolts joining the aft and forward fuselages. The two forward bulkheads are tied outboard by two longitudinal bulkheads to form a compartment for the engine oil tank. The skin is .032-gage formed aluminum sheet which is flush riveted throughout.

### Cowling

Cowling is attached to the fuselage at four main points: the gun compartment forward of the pilot cabin, engine com-

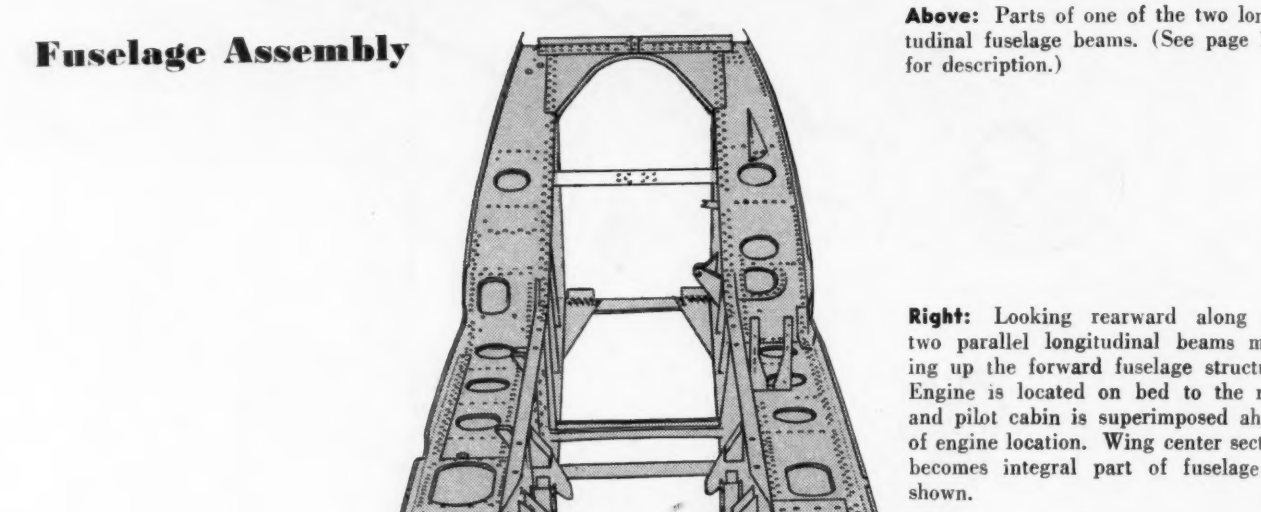
**Balance Factors**

| Center of Gravity Location | Aft L.E.M.A.C. | Above M.A.C. |
|---|---|---|
| C. G. location, normal gross weight, wheels up | 26.3% M.A.C. | 12.8 in. |
| C. G. location, normal gross weight, wheels down | 25.6% M.A.C. | 11.5 in. |
| Most forward C. G. location, wheels down | 24.3% M.A.C. | 12.8 in. |
| Most rearward C. G. location, wheels up, guns in place, no fuselage gun ammunition, overload fuel and oil less ⅓ | 28.0% M.A.C. | 11.8 in. |
| Extreme rearward C. G. location, wheels up, less fuel, no guns or ammunition in place | 34.5% M.A.C. | 13.4 in. |
| **Limit Flight Load Factors** | | |
| Limit maneuver load factors | Positive 8.0 | Negative 4.0 |
| Limit Gust Load Factors | | |
| Design gross weight | Positive 5.15 | Negative 4.44 |
| Minimum flying weight | Positive 5.44 | Negative 4.44 |
| Flaps down | Positive 2.01 | Negative 1.01 |
| **Limit Landing Factors** | | |
| Gross weight, 7,585 lb | 4.67g | |
| Limit Diving Speed | 170% of calibrated high speed | |

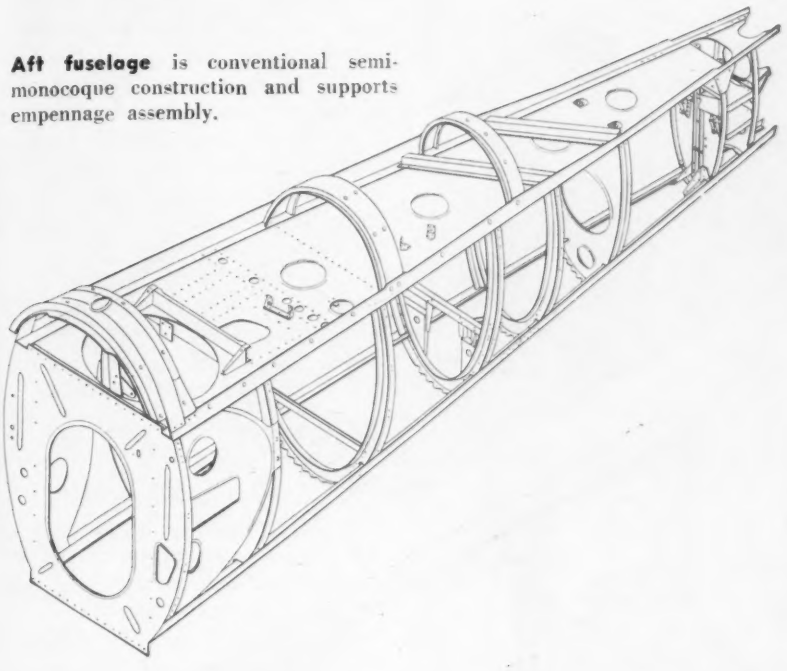


**Above:** Parts of one of the two longitudinal fuselage beams. (See page 127 for description.)

## Fuselage Assembly



**Right:** Looking rearward along the two parallel longitudinal beams making up the forward fuselage structure. Engine is located on bed to the rear and pilot cabin is superimposed ahead of engine location. Wing center section becomes integral part of fuselage as shown.



**Aft fuselage** is conventional semi-monocoque construction and supports empennage assembly.

partment, the Prestone and oil radiator compartments on the under side of the wing center section, and oil tank compartment in the aft fuselage behind the engine accessories bay.

Cowlings are formed aluminum sheet ranging from .051 gage at the gun, Prestone and oil radiator compartments to .032 gage at the engine and oil tank compartments. Access doors, an integral part of the cowling, are located in the engine compartment for access to the Prestone expansion tank, and in the radiator compartments for access to the Prestone drain. A section of cowling directly over the rear of the engine contains the carburetor air intake scoop. Another section, directly over the engine, houses the aft cabin Plexiglas enclosure.

Gun compartment cowl sections are attached to removable channel-shaped formers and bulkheads with flush-type fasteners. Engine compartment sections are strengthened with channel stiffeners and the radiator compartment cowls by several permanently riveted interlocking stiffeners.

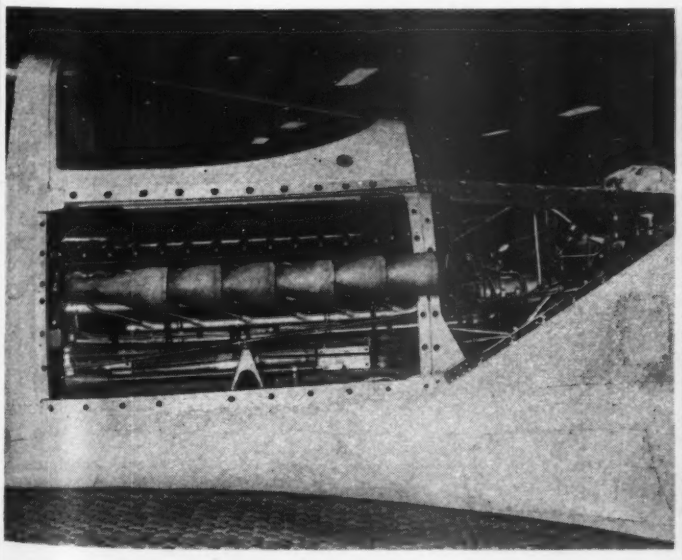
## Wing Center Section

The wing center section is in two parts, forward and trailing edges, both of which are designed as integral parts of the forward fuselage and wing outer panels.

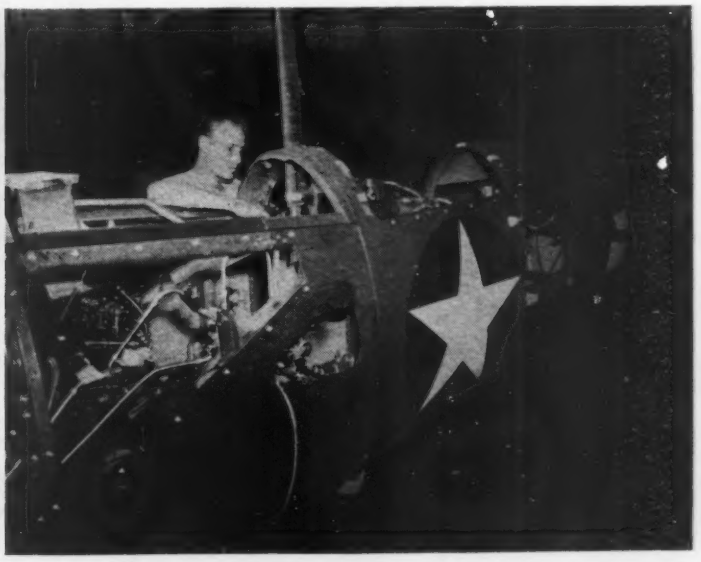
The forward structure is built up of six principal parts: a forward and a rear beam corresponding precisely to the main beams in the outer wing panels, two inner bulkheads, and two outer bulkheads for splicing to outer wing panels.

The forward beam consists of top and bottom capstrips of milled extruded aluminum shapes, tied by heavily reinforced aluminum webs in four principal panels. The two inside panels are solid single layer pieces. Outside web panels are made up of three layers of heavy gage aluminum, the center layer acting as a reinforcing member. The outside layers have formed 90-deg. flanges at the edge. These web panels have a dual function and must be so rigidly constructed. Large oval-shaped holes are cut through their centers to accommodate oil cooler ducts extending from the wing leading edge to oil coolers installed in the aft portion of the center wing section. In addition, four forged steel wing bolt fittings are fastened on each side, top and bottom of these web panels. In the main, they are much more than web panels, but vitally important structural members.

The rear beam is all formed steel except for the aluminum capstrips superimposed upon and riveted to the steel flanged web. The web is in two layers or sections riveted back to back. Strength considerations made it necessary to use steel for this member because four large holes are cut in the web to accommodate air ducts for the oil coolers (two outside circular holes), and air ducts for the Prestone radiator (two square in-

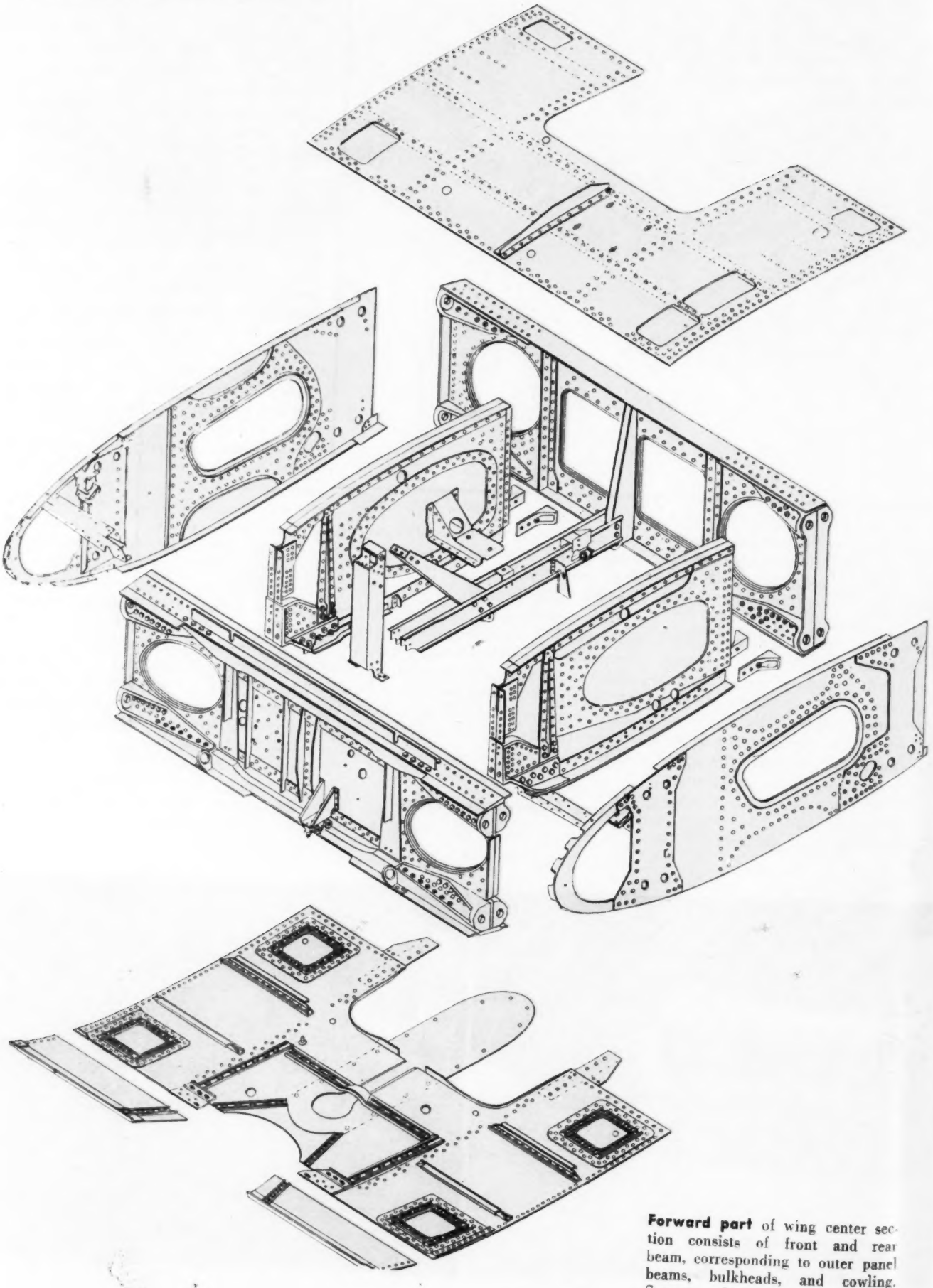


**Engine installation located aft** of the pilot cabin directly over rear portion of wing center section.



**Forward and aft fuselage sections** are joined by nuts and bolts through stiffeners and bulkheads just aft of engine compartment.

## Wing Center Section



**Forward part** of wing center section consists of front and rear beam, corresponding to outer panel beams, bulkheads, and cowling. Square and round holes in beams accommodate Prestone and oil radiator air ducts. Rear beam is all steel construction.

board holes), which is also located in the aft portion of the wing center section. As in the front beam, eight forged steel fittings for wing bolts are riveted to the steel web, lying snugly against the capstrip and side flanges.

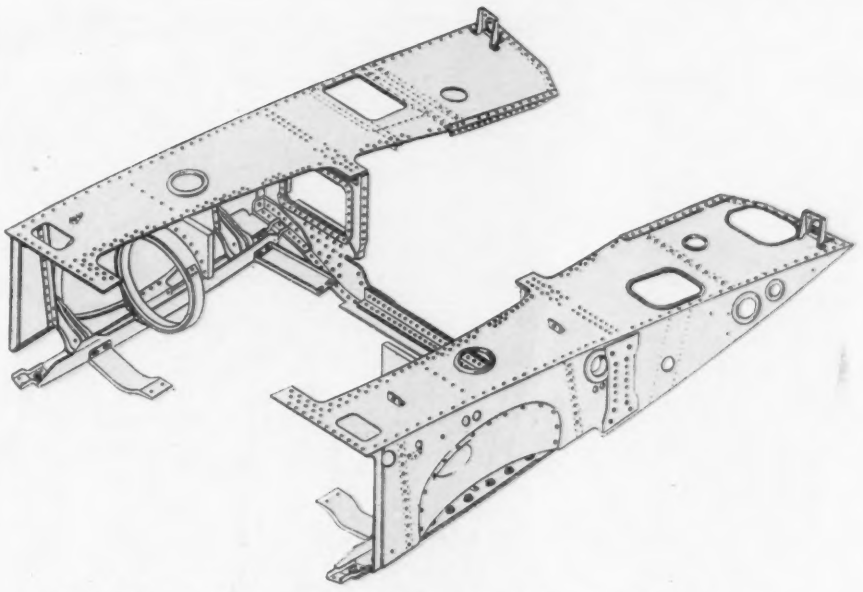
The two internal bulkheads consist of reinforced aluminum web sections riveted to extruded aluminum forming members. The outboard bulkheads, too, are reinforced webs with extruded angle forming members. Web sections are heavily reinforced where the wing bolts run through from the outer panel beams to fittings on the center section beams.

Top and bottom skin sections are formed aluminum sheet, reinforced with angle stringers and heavy plate where holes are cut for wing bolt access doors.

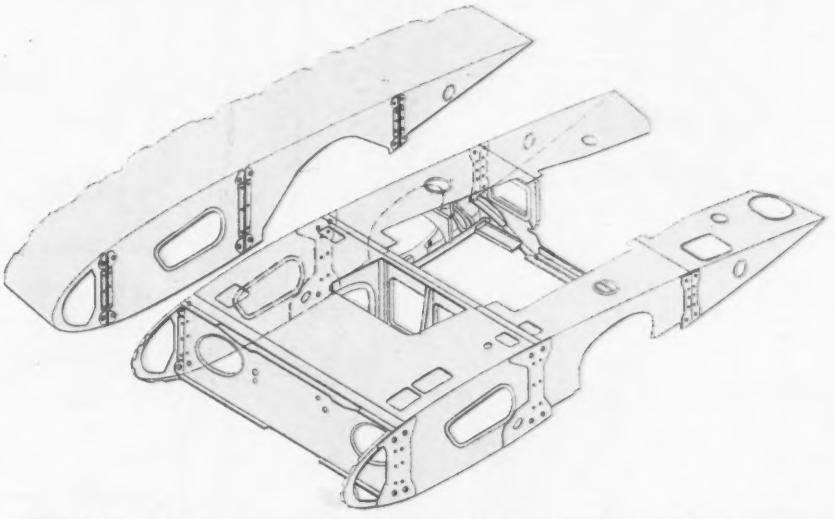
### Trailing Edge Section

The wing center section trailing edge consists of a single beam which acts as a carry-through member for the auxiliary beam of the outer wing panels. This beam is built up of formed sheet. Its sections are tied across by a heavy T-section extrusion further reinforced by extruded angle sections. Each side is cut through to accommodate air ducts to the Prestone radiator, which is mounted just aft of these beams and extends up through the longitudinal beams of the forward fuselage. Extending forward from the beam are parallel extruded channel sections to which outboard splicing bulkheads are riveted and upon which the partial skin covering is placed and riveted. Forged fittings are riveted to the auxiliary beam for additional wing splice bolts, and the bulkhead is strongly reinforced at these points.

The oil radiators are strapped into compartments formed by the bulkheads ahead of the auxiliary beam.



**Aft portion of wing center section** accommodates oil radiators and acts as carry-through member for wing panels from auxiliary beam to trailing edge.

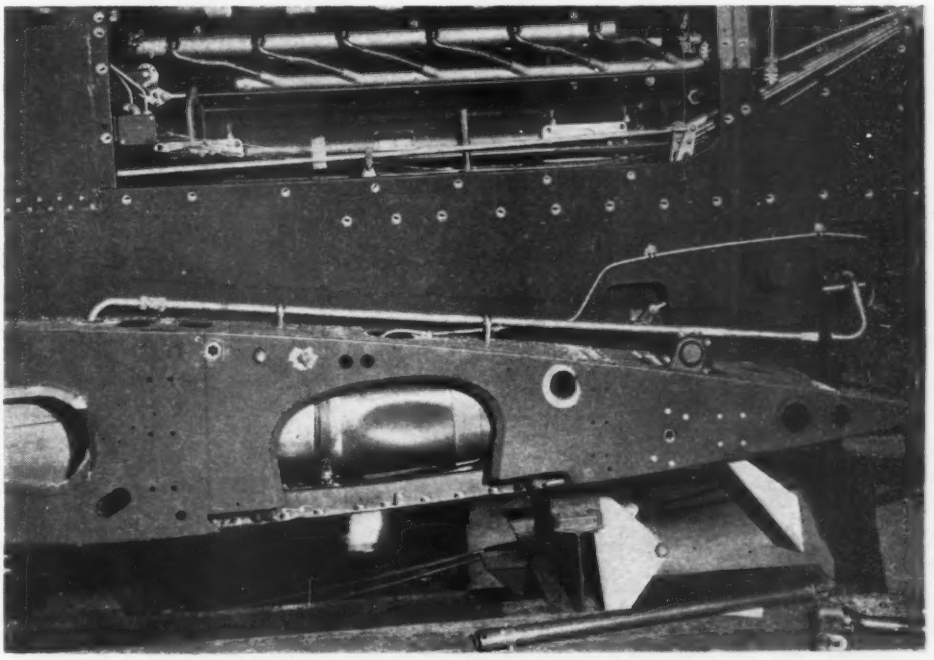


**Complete wing center section** showing splicing details for joining outer wing panels.

## Outer Wing Panels

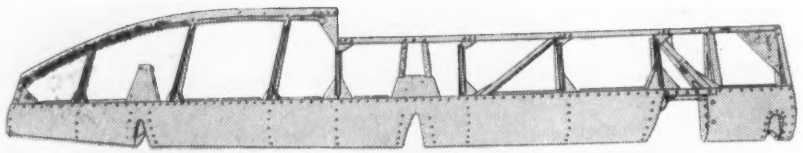
Outer wing panels are joined to the center wing section on each side at approximately 22 in. outboard of the P-39's center line of symmetry. Thirty bolts are used to make each splice, twelve are cold forged with recessed heads. There are also four large bolts at each front and rear beam connection, and four smaller ones at the auxiliary beam. In addition, six regular hex-head bolts are used at each of the three beam splices.

The three spars of the outer wing panel are called (from L.E. to T.E.) "front beam", "rear beam", and "auxiliary beam". Front and rear beams con-

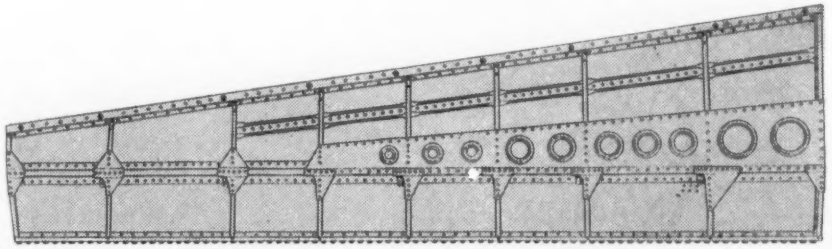


**Relation of wing center section** to fuselage assembly is shown here. Note oil radiator installed in wing section.

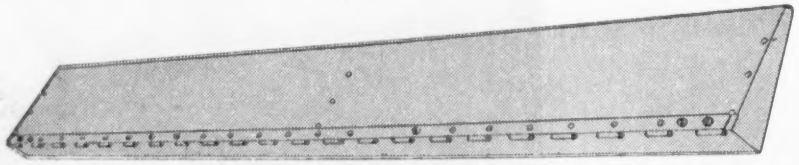
# Outer Wing Panel



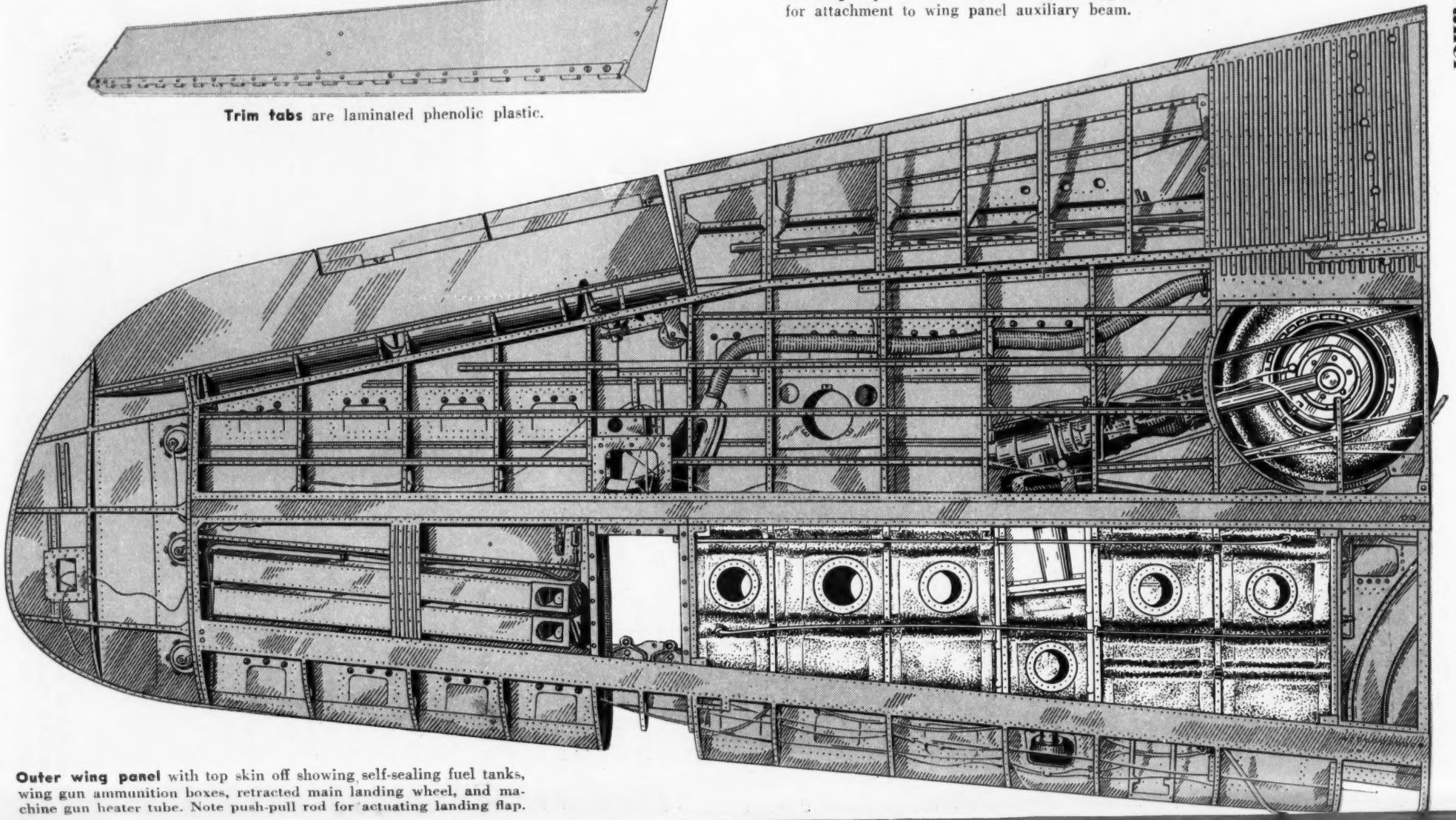
**Aileron** built up of extruded ribs and a single beam is fabric covered.



**Landing flap** of dural sheet has a piano type hinge for attachment to wing panel auxiliary beam.



**Trim tabs** are laminated phenolic plastic.



**Outer wing panel** with top skin off showing self-sealing fuel tanks, wing gun ammunition boxes, retracted main landing wheel, and machine gun heater tube. Note push-pull rod for actuating landing flap.

sist of flanged capstrips of extruded aluminum shapes milled to distinctive and exacting dimensions with the flange thickness tapering from a maximum of 0.865 in. at the inboard end to 0.154 in. at the outer tip. Solid heavy gage aluminum sheet webs with occasional stringers complete the beam construction.

The auxiliary beam is made up of formed aluminum capstrips with a solid aluminum web. The top capstrip is in dual sections running from the inboard splice bulkhead to just beyond the fifth bulkhead. In the trailing edge assembly, an intercoastal beam is installed for strength and also forms a compartment with the auxiliary beam for the flap actuating push-pull rod assembly. Running between the first and third trailing edge bulkheads are short beams to support the wing catwalk. The trailing edge strip is a drawn aluminum piece which clamps around the skin and is held together by rivets.

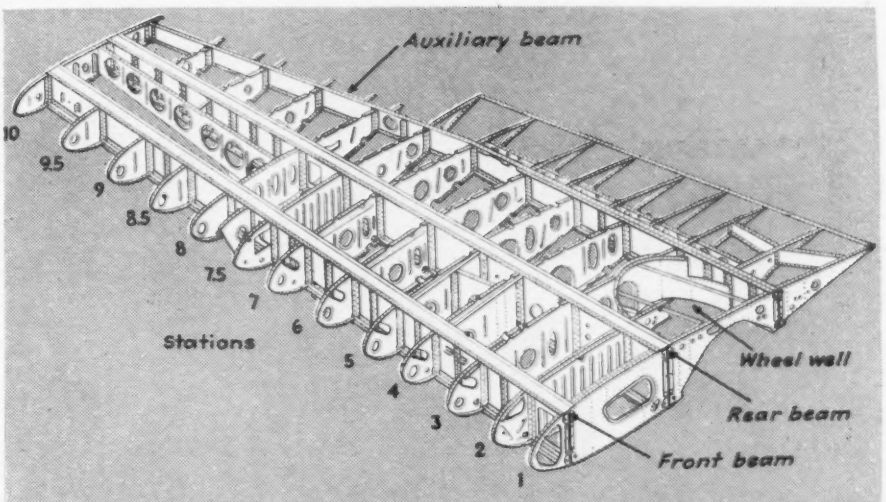
There are 13 principal wing panel bulkheads of pressed and beaded aluminum, ranging in gage from .072 for the inboard splice bulkhead to .064 for the wing tip splice bulkhead.

In the Bell production set-up, the bulkheads are numbered in stations from one to ten. Counting inboard, the first seven bulkheads are whole-numbered stations. The eighth bulkhead is Sta. 7.5, and each represents a half station from there to the thirteenth bulkhead at Sta. 10.

Compartments formed by bulkhead Sta. 2 to Sta. 7.5 between front and rear beams accommodate the self-sealing fuel cells. A longitudinal bulkhead between Stas. 4 and 5, about one-third of the distance forward from the rear to front beam, forms a compartment for the main landing gear retracting spindle assembly. Twin .30-cal. machine guns are installed between Stas. 7.5 and 8, with a false rib bulkhead between them.

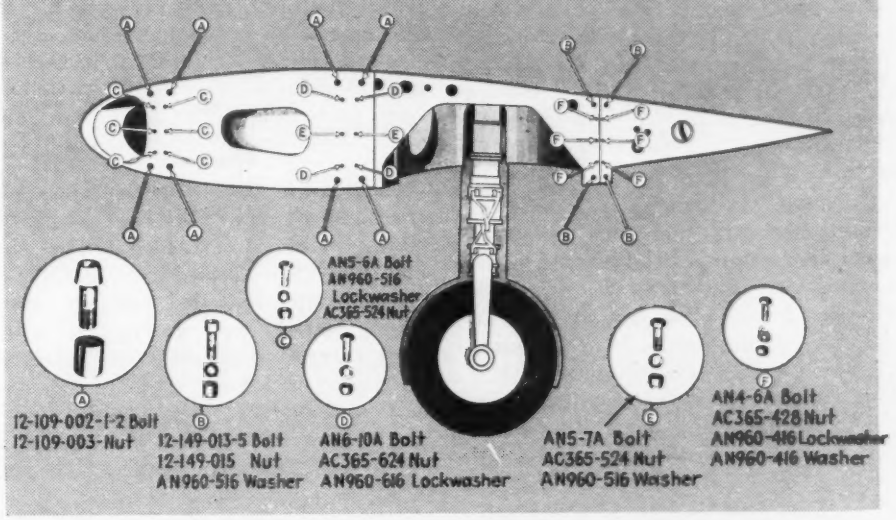
An intercoastal beam of formed, blanked, and beaded aluminum sheet webbing between drawn aluminum capstrips runs between Stas. 8 and 10, about midway between front and rear beams, forming a compartment with the front beam to accommodate wing ammunition boxes.

The landing gear wheel wells between Stas. 1 and 2 are shaped of formed and drawn aluminum capstrips with formed aluminum sheet webbing. Two angle-shaped stringers extend from Sta. 1 bulkhead over the top of the wheel well to the outer periphery to reinforce the wing catwalk.




**Outer wing panel skeleton** showing stations and details of beams and bulkheads.

**Details of wing splice bulkhead** showing wing bolts and their location.



**Landing flap** is powered by ½-hp. electric motor located on beam deck of forward fuselage.

**Airfoil Data**

| | |
|---|---|
| Root | NACA 0015 |
| Tip | NACA 23009 |
| Root chord (22 in. outboard of airplane centerline) | 98.6 in. |
| Tip chord (204 in. outboard of airplane centerline) | 50.0 in. |
| Taper ratio | 1.97:1 |
| Angle of incidence | plus 2 deg. |
| Dihedral (at 30% upper ordinate) | 4 deg. |
| Sweepback (L.E.) | 4 deg. 35 min. |
| Maximum rib spacing | 16 in. |
| Spar locations: | |
| Front spar—at root chord 11 in. approx. aft of L.E. root chord at tip chord, 25 in. approx. aft of L.E. root chord | |
| Rear spar—40 in. approx. aft of L.E. root chord and normal plane of symmetry. | |
| Aspect ratio | 5.42 |
| M.A.C., length | 80.64 in. |
| location | 5.41 in. aft of L.E. root chord, and 6.62 in. above L.E. root chord |
| Aileron area (two ailerons) | 15.46 sq. ft. |
| Aileron location (dist. from line of symmetry of centroid of aileron area) | 150.18 in. |
| Aileron static balance | approx. 100% |
| Trim tab chord | 3 in. |
| Trim tab span | 22 11/16 in. |
| Trim tab area (each tab) | 0.47 sq. ft. |

### Wing Skin

The lower surface wing skin is in three principal sections, forward and aft of the rear beam, and the leading edge. Each section consists of two panels running inboard to approximately Sta. 7.5 and from there to Sta. 10.

The two aft panels are .025-gage formed sheet with numerous reinforced access door cutouts. The inboard panel between rear and forward beams is .051-gage formed sheet, largely built up with reinforcing panels. The outboard front panel is .032-gage sheet with a large access door of the same gage aluminum for the wing ammunition cases. The leading edge is .032-gage formed sheet.

The skin from top to lower surface consists of panels similar in arrangement and gage. The inboard forward panel has a number of reinforced access holes for fuel tanks; the outboard forward panel has a large door for installation or removal of wing guns. Skin stringers are, for the most part, Z-section, rolled or drawn aluminum. Flush riveting is used throughout.

### Wing Tips

The wing tip comprises two bulkheads and three tapering beams. The wing splice bulkhead is built up of rolled capstrip and sheet webbing of .064-gage aluminum. The internal bulkhead is in three sections, each of formed beaded sheet, with a series of beaded lightening holes. These bulk-head sections are riveted to the beam. Beams are also formed and blanked sections: the trailing edge beam is riveted to the rear section internal bulkhead in two sections. Skin stringers are drawn hat sections riveted across the beams. Tip edge is a formed aluminum strip enclosing the skin, which is .032 gage, entirely flush riveted.

### Ailerons

Ailerons are fabric covered monospar structures of the "Frise" type with built-up ribs of extruded shapes in some cases and formed ribs in others. The built-up ribs, tied together with gusset plates, are capstripped with metal channel assemblies used in conjunction with thin metal retainer strips to tie down fabric skin covering, giving a flush surface. Leading edge ribs are formed and blanked sheet riveted to the .040-gage alclad beam. Trailing edges are formed strips enclosing the skin fabric.

### Trim and Servo Tabs

Controllable trim tabs of laminated phenolic plastic are located at the trailing edge of each inboard aileron. These trim tabs also act as a servo control through a mechanical linkage which automatically rotates the tab to an angle opposite to the movement of the aileron, creating a force which reduces the energy required to actuate the aileron. An additional servo tab of laminated plastic, not controllable by the pilot, is located just outboard of the trim tabs. The servo tabs are actuated by a mechanical linkage attached to the aileron hinge bracket maintaining the servo tab at a neutral setting 2 deg. above the thrust line of the airplane with the ailerons positioned at any angle in flight.

### Wing Flaps

The wing flaps are split trailing edge type and form the lower rear surface of the outer wing panels. They extend from Sta. 1 to the inboard end of the aileron. Attached to the wing by a piano type hinge extending the full flap length, they are connected to the auxiliary beam lower flange. Flaps are operated by a push-pull tube and an electrically driven connecting link mechanism. The operating member consists of five turnbuckle connecting links between the flap beam and the push-pull tube.

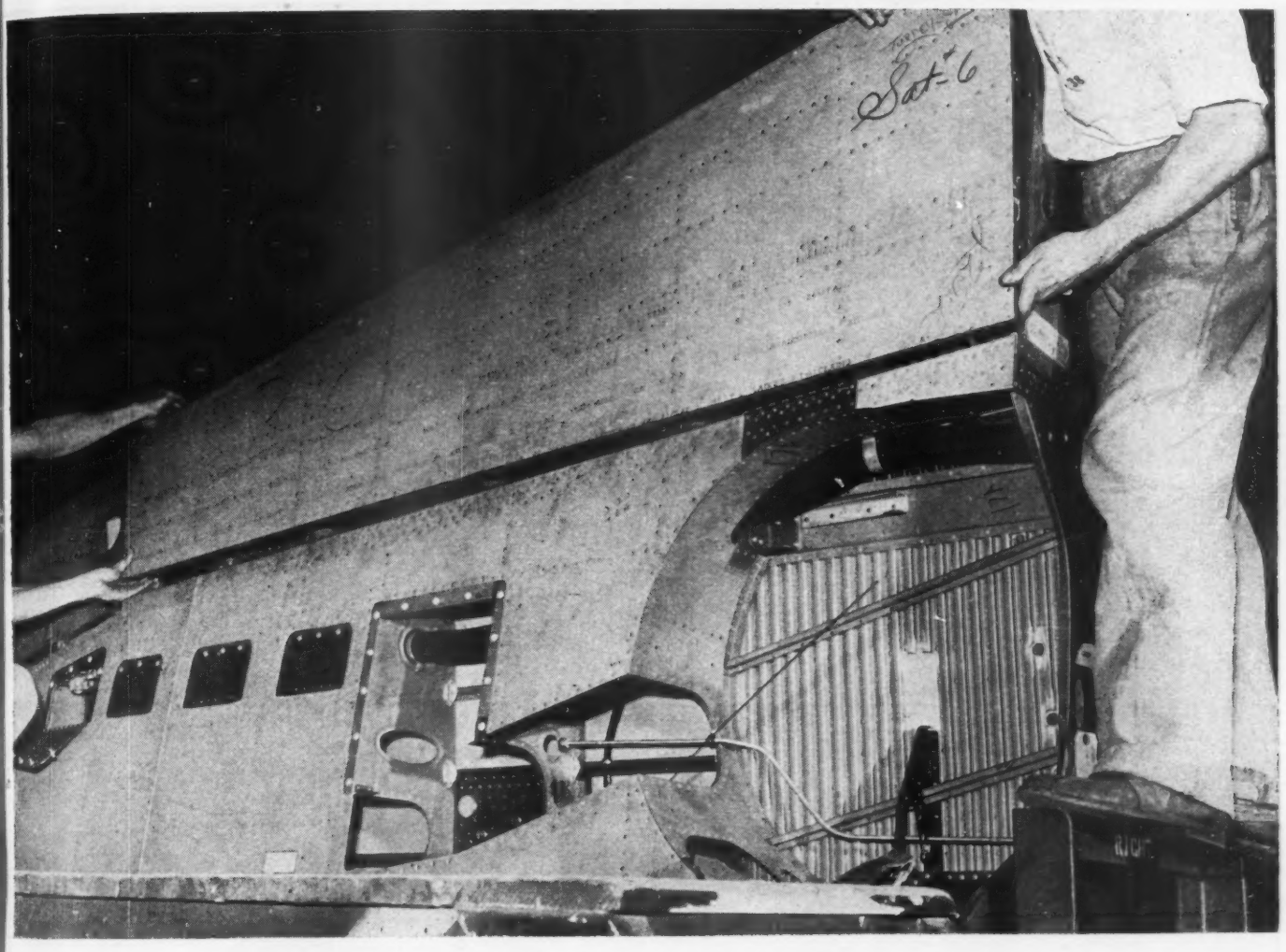
The single beam is a formed channel section of .040-gage aluminum. Ribs are formed solid sheet sections in two parts, riveted fore and aft of the beam. Skin stringers are also formed channel flanged sections. Skin is a solid panel of .025-gage sheet. A doubler sheet with a number of blanked lightening holes is riveted to the ribs forward of the beam. The flaps are stressed so that full extension (43 deg.) may be used at 150 mph. maximum speed.

## Empennage

The horizontal stabilizer is constructed as a single unit with sections cut away in the center to permit access of the vertical stabilizer to the fuselage. It is a twin-spar structure of conventional stressed skin design. The forward beam is constructed in three flanged sections formed of heavy gage sheet. The center section is a short member, perpendicular to the airplane center line, to which are attached two outer beam sections with a pronounced sweepback, approximately parallel to the leading edge. A series of false ribs of formed and blanked aluminum sections form the leading edge.

The rear beam, formed from .072-gage sheet, is in two half sections spliced with a riveted aluminum plate. Each half section has a solid formed sheet tip attached with rivets. About half way from center on each side, forged aluminum alloy steel hinge fittings for the elevators are fastened to the rear beam. The front and rear beam are tied together with a series of blanked and formed bulkheads. Z-shaped stringers support the flush riveted skin. The leading edge skin is a single formed section on each side, extending from the top flange of the front beam around the forming ribs to the bottom flange.

From the front beam to the rear edge, the skin is in four formed aluminum sheet sections, two on each side, top and bottom. Stabilizer tips are single formed aluminum sections riveted to the single rib of the stabilizer proper. Four threaded studs, two on each beam, pro-



**Attaching landing flap to wing auxiliary beam.** Underside of the top skin shown through wheel well is corrugated to provide strength for catwalk. Note heater hose for wing guns.

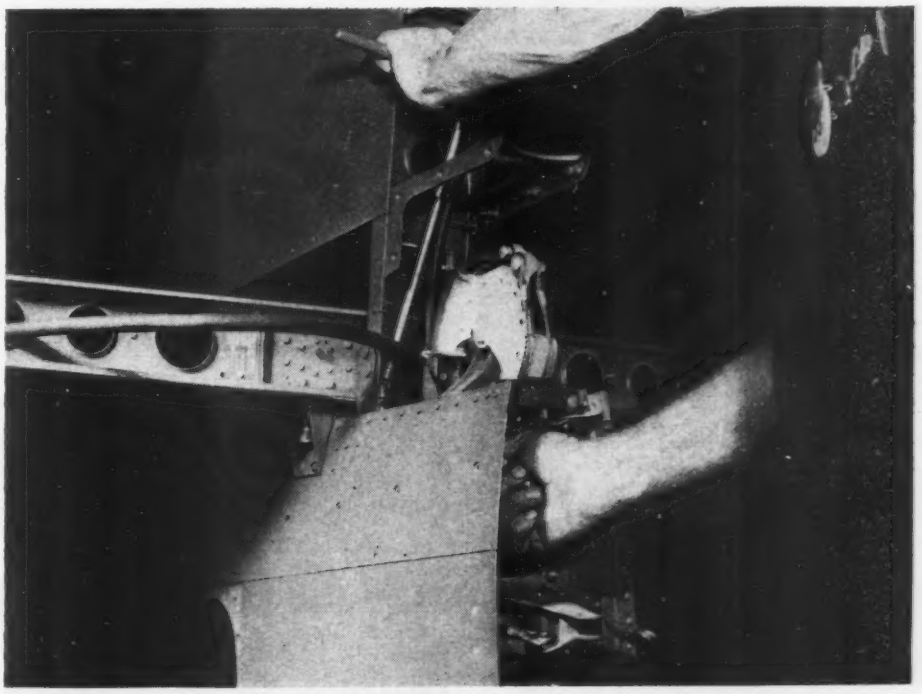
vide for attaching the stabilizer to the aft fuselage with lock nuts.

### Elevators

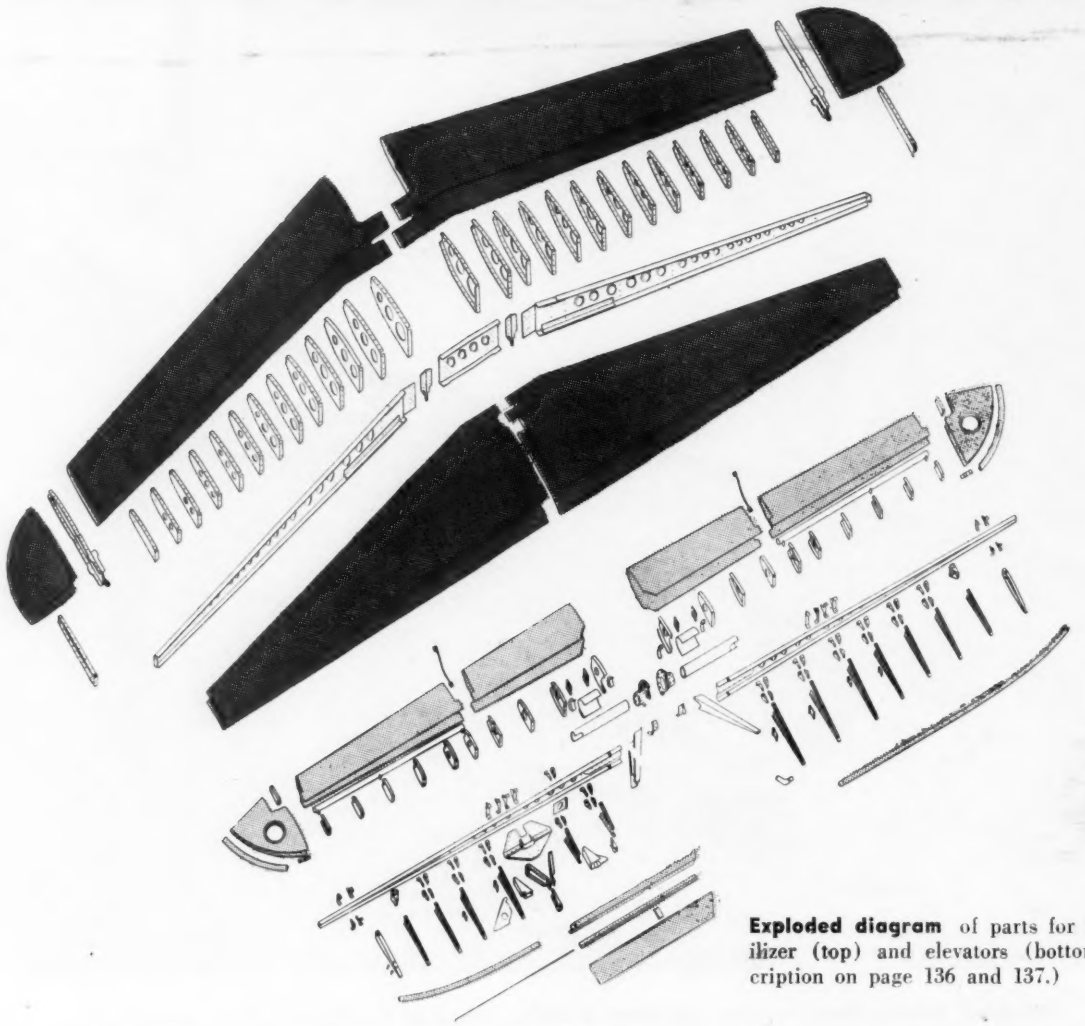
Fabric covered elevators are similar in construction to the ailerons. Right and left hand elements are joined at the control quadrant by tubular steel members spliced by forged, flanged steel collars. The left elevator has a trim tab fastened to an auxiliary beam just forward and inboard of the trailing edge section. Two hinge settings are installed on the main beam and attached to the horizontal stabilizer. A mass-balance, tubular-shaped weight, used for dynamic and static balancing, is located in the foremost section of the leading edge.

### Vertical Stabilizer

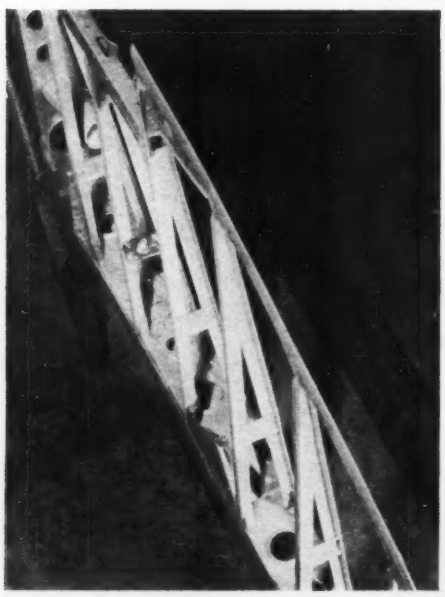
The vertical stabilizer is similar in structure to the horizontal stabilizer, except that beams are one piece construction. A hole is cut in the skin on both sides for the navigation light installation. Cast fittings are installed on the projecting ends of the main and



**Control quadrant for operation of elevators** is attached to aft fuselage just behind the horizontal and vertical stabilizers.



**Exploded diagram** of parts for horizontal stabilizer (top) and elevators (bottom). (See description on page 136 and 137.)



**Close-up of extruded ribs** used on rudder which are typical of those used on all control surface structures.

rear beams for attachment by nuts and bolts to the aft fuselage. Two hinge fittings are riveted to the aft flange of the rear beam for the rudder attachment.

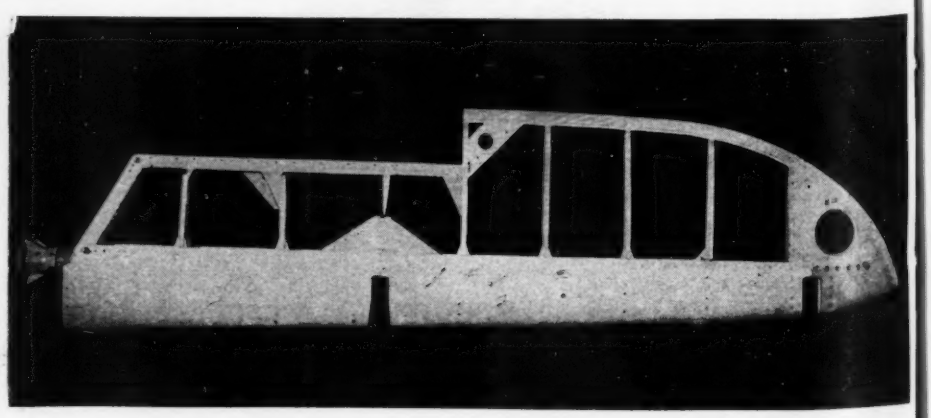
### Rudder

The fabric covered rudder is similar in structural arrangement to the elevators and ailerons. However, the top and bottom portions are covered by formed and beaded aluminum sheet. Two hinge fittings for fastening to the vertical stabilizer and rudder control quadrant are installed on the main beam. The auxiliary beam supports a plastic trim tab, and a round mass-balanced weight is mounted in the foremost section of the leading edge.

Nine pieces of formed aluminum sheet and formers comprise the empennage fillet assembly, which is attached by flush screws and channel nuts.

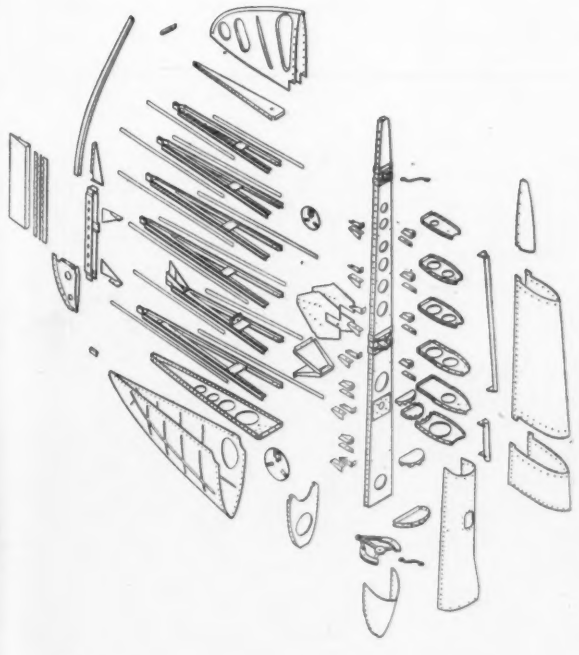
## Pilot Cabin

The cabin with its six transparent panels, arranged for maximum visibil-

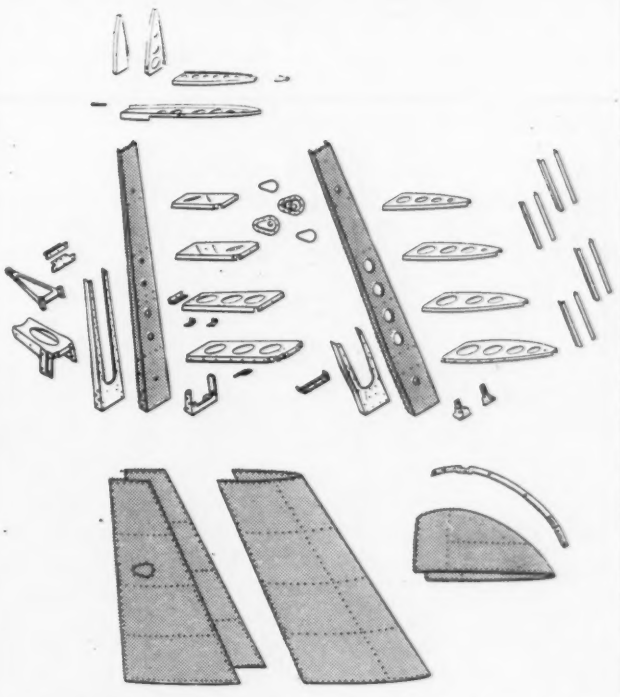


**Left elevator** showing provision for trim tab and forged collar on control bar.

# Empennage

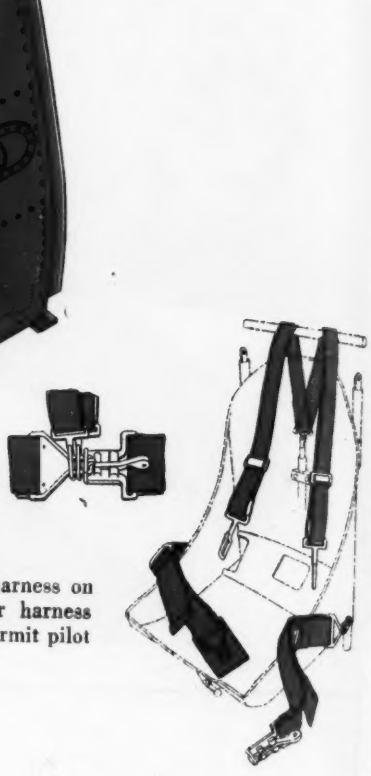


**Exploded diagram** of rudder parts. (See description of page 138.)

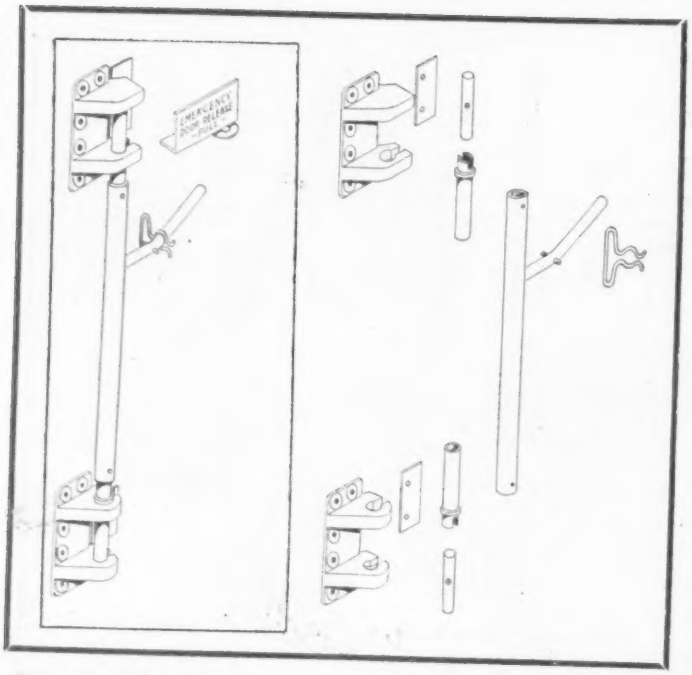


**Exploded diagram** of parts for vertical stabilizer. (See description on page 137.)

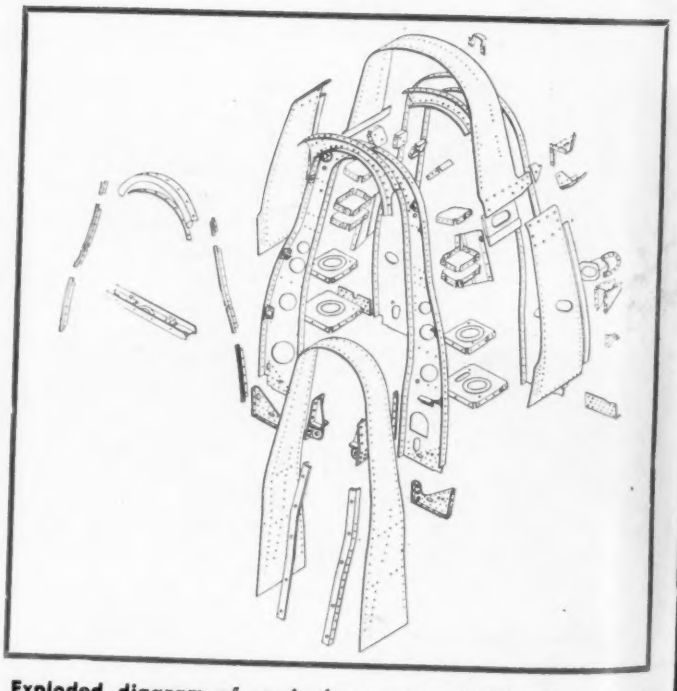
# Pilot Cabin



**Details** of Sutton harness on pilot seat. Shoulder harness can be released to permit pilot to lean forward.



**Emergency door handle** assembled and disassembled. (See descriptions on page 141.)



**Exploded diagram of parts** for turnover bulkhead. (See description on page 141.)

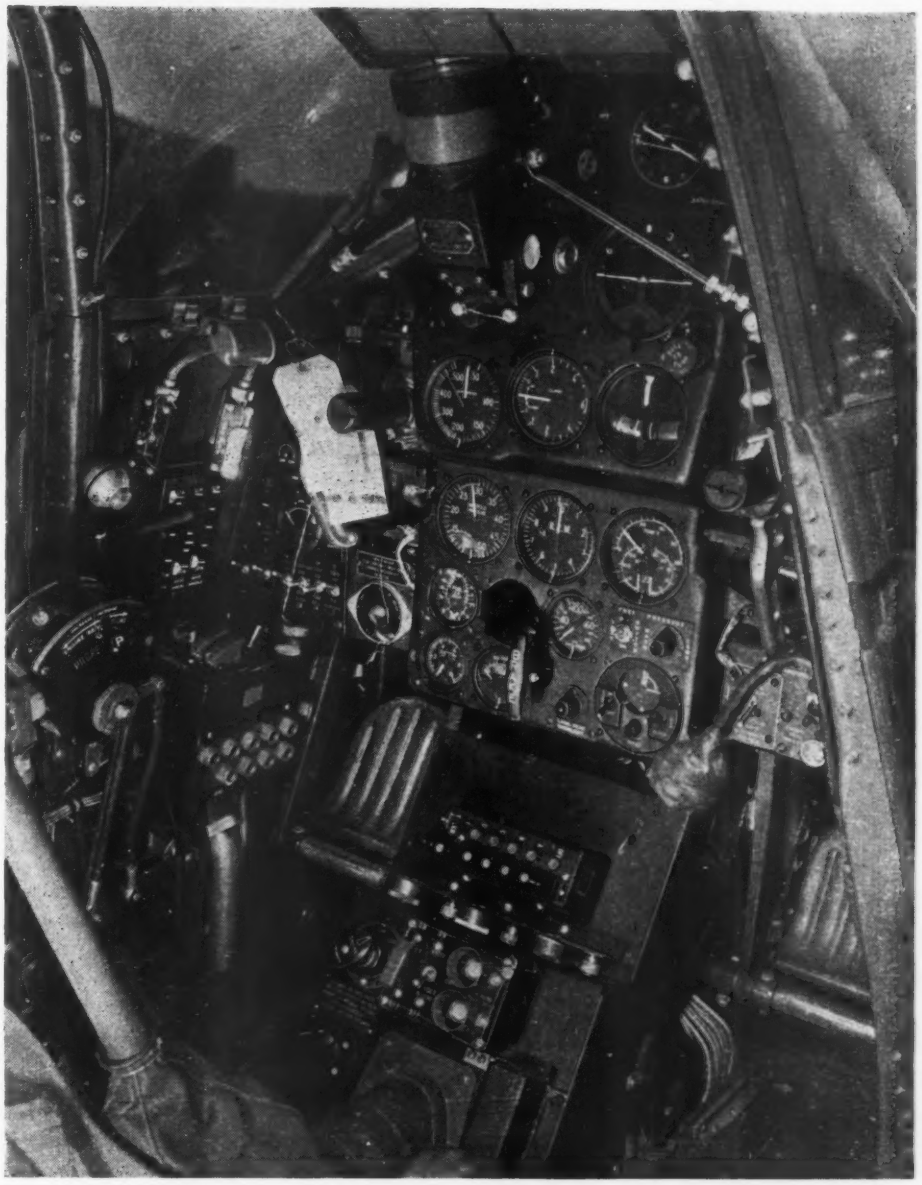
ity, is in two sections--the forward cabin for the pilot, a permanent built-up structure superimposed upon and forming an integral part of the forward fuselage ahead of the engine; and the removable aft cabin enclosure directly over the engine and joining the forward section at the turnover beam.

The forward section consists of drawn aluminum frames for the glass and Plexiglas enclosures as well as the formed aluminum skin sides forward of the door. Directly ahead of the pilot is a windshield panel of ¼-in. laminated shatter proof glass; two side windshield panels are ¼-in. convex Plexiglas and directly overhead is a panel of 5/32-in. Plexiglas formed to the cabin contour. All panels are set in rubber channel retainer strips.

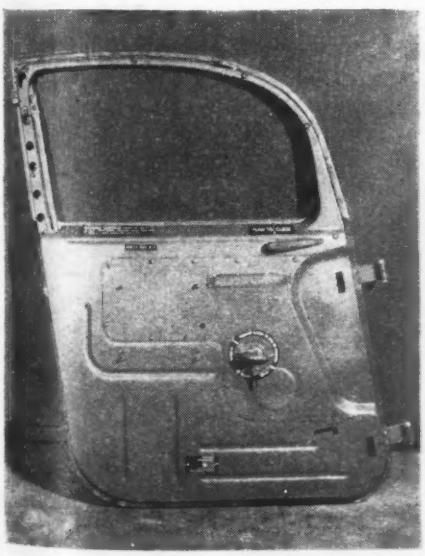
Aluminum automobile type doors are located on both sides of the cabin. Both have a 3/4-in. roll down laminated glass panel operable on the ground or in the air at any speed up to design high speed in level flight. Emergency door release handles, painted red, are just forward of each door frame in the cockpit. When the handle is pulled out and turned 90 deg., the hinge pin is parallel with the door release slot and the door is free to be pushed outward away from the airplane. Both cabin doors are held tightly closed by a door latch at the top to prevent the door from opening at high speeds. This fastening is broken when the emergency handle is operated.

### Instrument Panel

The main instrument panel, constructed of one piece of aluminum alloy, is flexibly mounted on three Lord mounts just below the center windshield. An auxiliary instrument panel is set to the immediate right of the main panel and attached directly to the fuselage. A left hand panel consists principally of switches controlling the electrical installations. There are some 36 instruments and sets of switches.



**Controls and instrument panel in pilot cabin.** Device under front windshield is electric gun sight. Clock installation below RPM indicator is missing in this photograph.



**Cabin door** is automobile type with roll down glass panels.

### Pilot Seat

The pilot's seat is bucket-type, metal construction, and non-adjustable. A Type B-11 Sutton safety harness is attached to the seat with a roller mechanism and is released or locked by a control under the seat. The cabin is designed to accommodate a pilot 5 ft. 8 in. high, weighing 200 lb. with parachute.

### Turnover Bulkhead

The turnover bulkhead behind the pilot is of extremely rigid construction capable of withstanding loads considerably in excess of the airplane weight. It consists of two main beams of very heavy gage aluminum tied together by a number of formed and blanked bulkhead sections and heavy gage formed aluminum skin flush riveted to the beams and bulkheads. Additional strength is provided by crossed streamline wire bracing tightened by turn-buckles running from the top of each side of the assembly to the bottom of the other side.

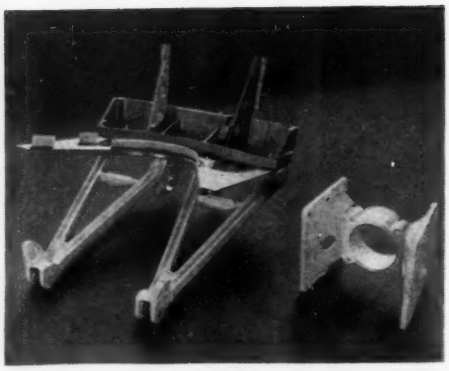
### Aft Cabin

The aft cabin is a shallow streamline structure conforming to fuselage contours. It consists of channel formers and a beaded aluminum deckplate for housing a portion of the radio installation. It is enclosed by two convex panels of 5/32-in. Plexiglass.

Differing from the forward pilot cabin, which is permanent, the aft cabin section is removable. It joins the forward section at the turnover beam.

## Landing Gear

The *Airacobra* is equipped with a fully retractable tricycle landing gear. Nose wheel is self-castering, non-steerable type and retracts up and aft into the forward fuselage; the main wheels retract up and inboard into the outer wing panels. Retracting mechanism is operated by an electric motor through a system of torque tubes, universal joints, gear boxes, and splined connections. Operation of the landing gear motor is governed by a toggle switch in the pilot cabin. In the event of power failure, the wheels can be operated by an emergency ratchet crank at the right of the pilot's seat.



**Forged A-frames** located in forward fuselage to which are attached nose wheel strut retracting links.

### Shock Struts

Cleveland Pneumatic Tool air-oil shock struts are used on both nose and main gear. Main gear struts are attached to a fitting of the spindle assembly in the wing panel by four nuts and bolts. The forged steel landing gear fork is attached to the piston tube of each strut which operates with the wheel. Conventional torque scissors are employed on the main and nose wheel installations.

The nose wheel shock strut is hinged to the forward fuselage inside the nose wheel well and is retracted by a linkage assembly. A centering cam is installed in the oleo strut keeping the wheel in a central position and preventing it from fouling against the airplane during retraction. An adjustable Houde Engineering shimmy absorber is installed in the lower end of the strut piston tube.

The nose wheel fork is a steel forging connected to the lower end of the strut assembly by four bolts, located in pairs at the front and rear of the fork, and lockwired in pairs. Holes are tapped in the lower end of the piston tube and lined up with the fork bolt holes.

The nose wheel is mounted on a chrome molybdenum cadmium plated, steel tube axle, which slides through the fork ends from left to right and is held in place by a large nut lockwired to the fork. The tire is 19 in. in diameter with a high pressure dual seal safety tube.

Oil and gas resistant, plyable rubberized boots are fastened onto each wheel strut assembly with a criss-cross lace. At the top they are held by fairing clamps and at bottom by two slots into which the two fork-to-scissors brackets are inserted.

### Wheels and Brakes

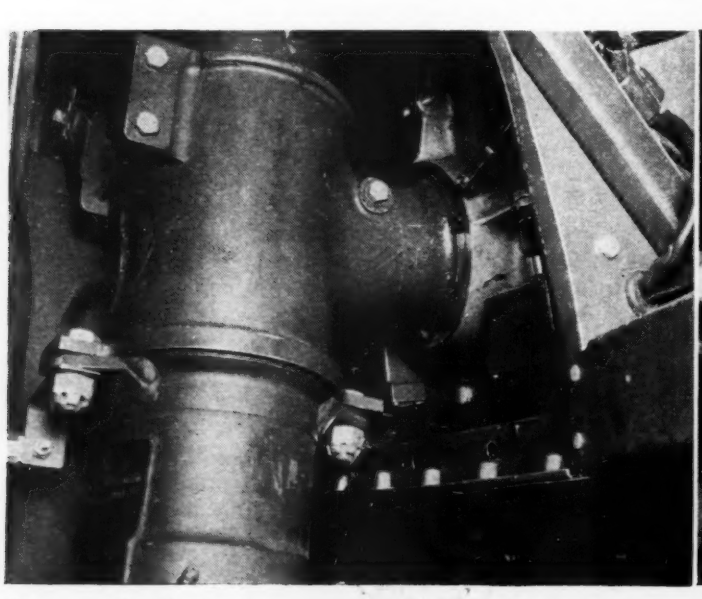
The main wheels are magnesium alloy equipped with 10.0Hx5 disk type hydraulic brakes. Main wheel tire castings are 26x6 in., 6-ply, rayon, with high pressure, puncture proof tubes. Three types of interchangeable tires are used—treaded for ice or snow-packed fields, flat contour for desert or sandy fields, and smooth contour for normal operations.

Each main wheel brake assembly has eleven plates, six stationary steel disks and five movable brass disks. The stationary disks are held in place by six slots on the inner side which slide over six tongues on the axle hub. The movable disks have six tongues on the outer edge which slide into six corresponding slots in the brake drum. A Warner hydraulic master brake cylinder and brake pedal assembly are mounted in a vertical position and pivoted on each end of the rudder control pedal cross bar in the cockpit. Master brake cylinder units are connected to the brakes by a flexible leather-covered rubber hose and $\frac{5}{8}$ O.D. aluminum alloy tubing. A control on the main instrument panel operates a parking brake in conjunction with the main wheel brakes.

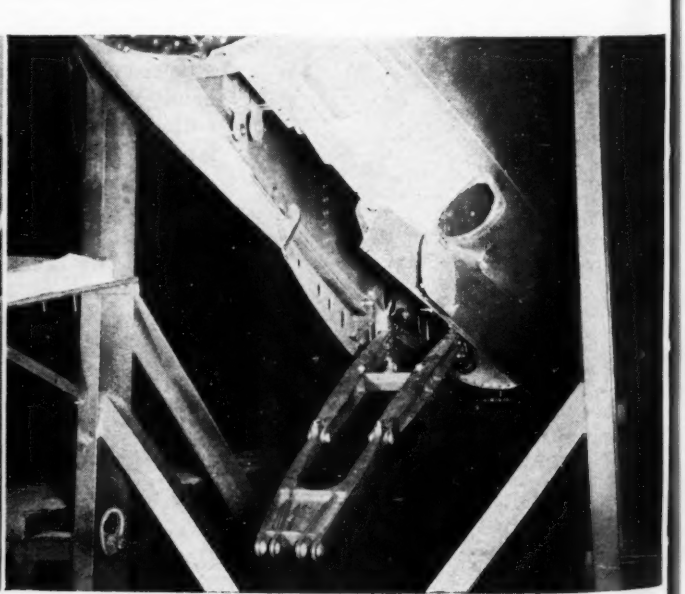
### Retracting Mechanism

The landing gear is operated by a reversible, 24-volt motor giving $\frac{3}{4}$ hp. at 3,800 rpm. Incorporated in the assembly are a clutch and reduction gear drive with a 40 to 1 ratio. The clutch is designed to slip at an output torque (at slow speed shaft) of 700 in.-lb. The motor is mounted on the forward fuselage deck at the right side of the engine. An operating control switch is mounted just forward of the left-hand cabin door in the cockpit.

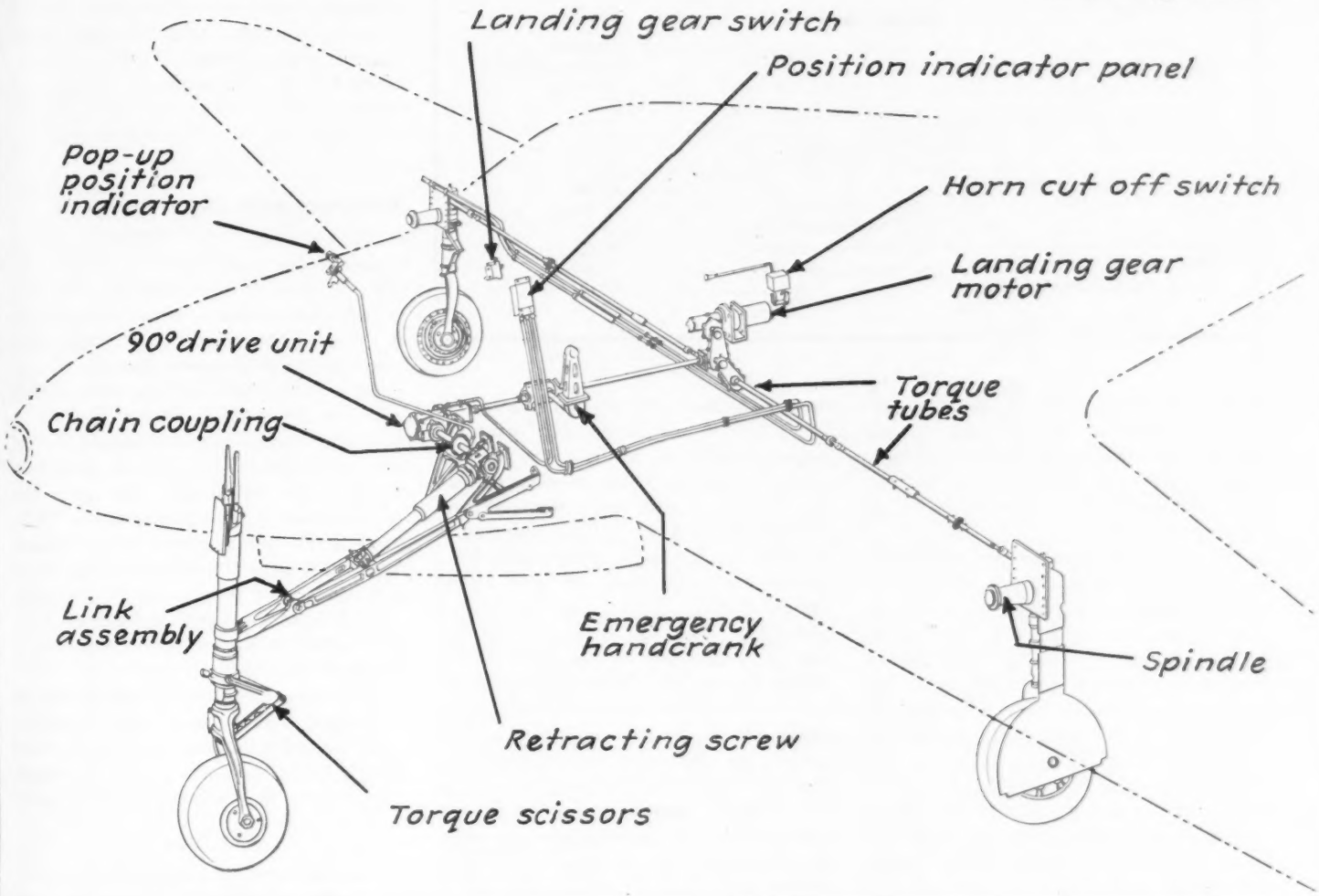
Main wheels retract into the wing by means of a worm sector gear which is installed with a spindle assembly on the aft face of the rear main beam by twelve nuts and bolts lockwired in pairs. Each strut is attached to a fitting of the spindle assembly by four nuts and

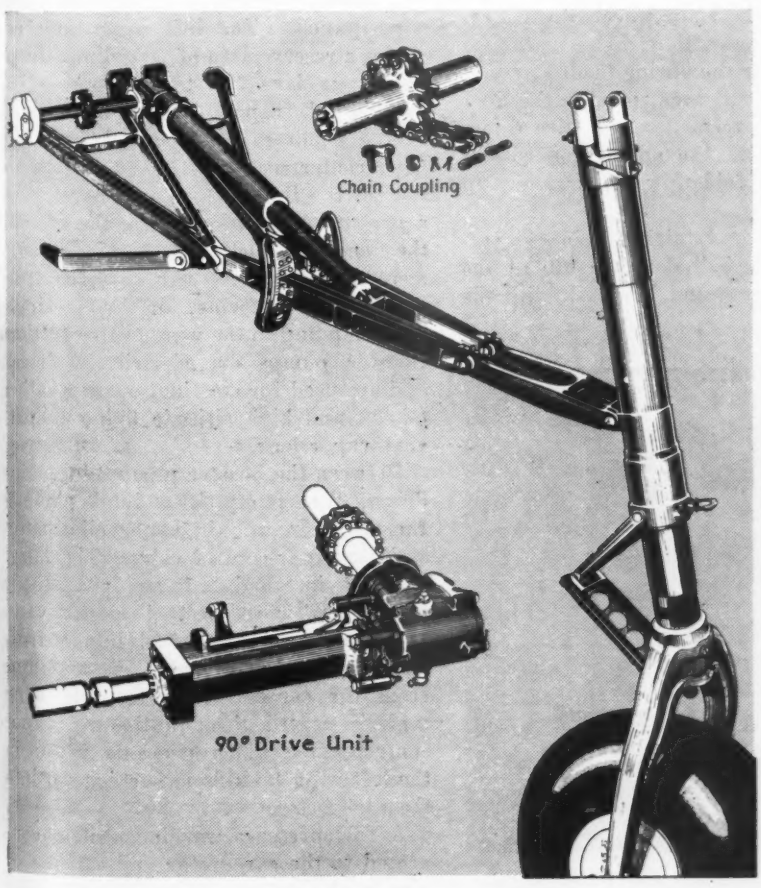


**Close-up of main landing gear strut attachment** to spindle at rear beam of outer wing panel.

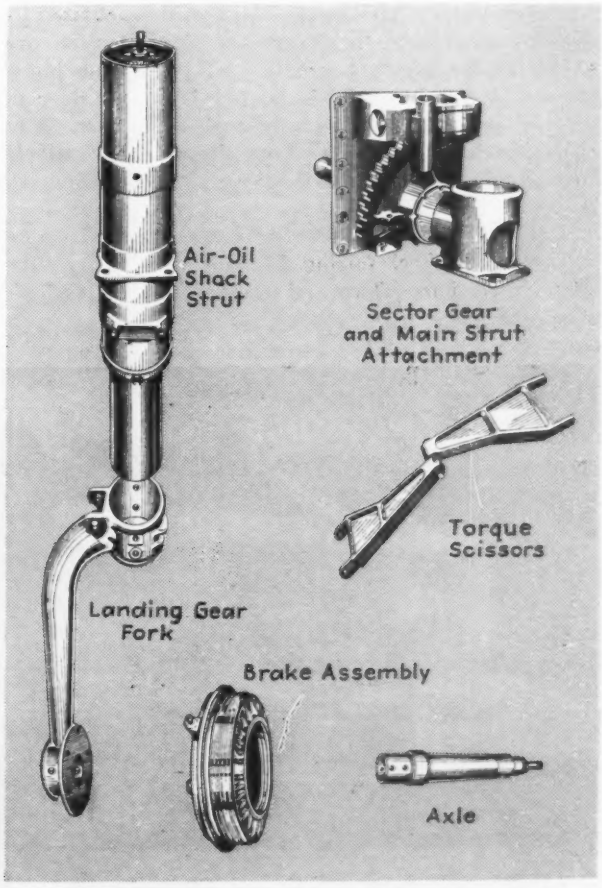


**Retracting link and wheel well** for nose wheel in forward fuselage.




**Component parts** of nose wheel gear assembly. Nose wheel retracts in unison with main gear.




**Component parts** of a main landing gear strut and brake assembly.

**Landing Gear Data**

| | |
|---|---|
| Type | Tricycle |
| Wheel construction (all wheels) | Magnesium alloy |
| Wheel base | 119 ¾ in. |
| Tread | 136 in. |
| Main gear oleo travel (total) | 8 in. |
| (from extended to static) | 5 in. |
| (from static to compressed) | 3 in. |
| Nose wheel oleo travel (total) | 10 in. |
| (from extended to static) | 7 in. |
| (from static to compressed) | 3 in. |
| Nose wheel swivel (either side of plane of symmetry) | 60 deg. |
| Main wheel diameter | 26 in. |
| Nose wheel diameter | 19 in. |

bolts. A worm gear installed in the spindle assembly is actuated by the landing gear motor by means of torque tubes. The worm gear rotates the sector gear, which in turn retracts or extends the wheels.

Nose wheel retraction mechanism consists of a retracting screw installed in the forward fuselage and driven by the landing gear motor through torque tubes and a 90-deg. gear drive. This actuating screw is attached to the main leg of the nose wheel linkage assembly. A coupling shaft links the retracting screw and gear drive.

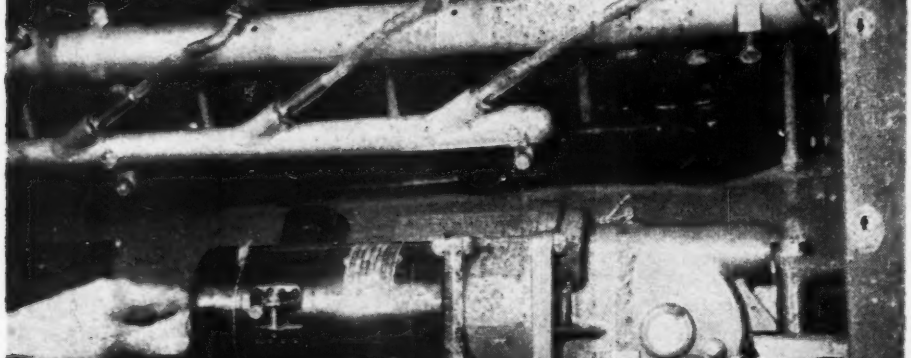
The retracting linkage consists of a short link, attached to the oleo strut, to which is hinged a large or main link, hinged in turn to two A-frame fittings in the fuselage.

The emergency handcrank is equipped with a ratchet and can be reversed by a switch at the top outboard face of the crank. A clutch handle is located just aft and outboard of the handcrank on the cabin floor, to change from electric to manual operation or vice versa.

### Landing Gear Fairings

The main wheel fairing is made up of three sections. Two are attached to the main wheel strut at two points. The lower section of fairing laps over the upper section, but the two are not connected in any way, the overlap permitting motion of the oleo strut without damage or buckling. Lower section is attached at the main wheel axle by a washer and castellated nut and to the upper portion of the fork by a link assembly. The upper section of the fairing is attached to the strut in two places by clamps. Five bolts hold the lower clamp and four hold the upper clamp to the fairing. Each clamp is held to the strut by a bolt and locknut. The third section of fairing, known as the "flipper door," is hinged to the lower surface of the wing center section near the wing splice bulkhead. It opens toward the airplane centerline and is actuated by the main wheels during extension and retraction. The wheel extends allowing the spring-loaded arm of the door to straighten, forcing the door open. Upon retraction, the tire comes in contact with the spring loaded-arm causing it to fold upward, drawing up the door.

The nose wheel fairing is in two sections. One is bolted to the top of the nose wheel strut and lies flush with the undersurface of the fuselage when the wheel is retracted. The other section consists of right- and left-hand doors hinged to the forward fuselage at four hinge points. These doors are actuated by a spring loaded arm in a manner similar to the main wheel fairing doors.



**Landing gear motor** is ¾ hp. and is located on deck of forward fuselage longitudinal beam.

## Engine and Accessories

The Allison Type V1710 engine is mounted on four "Fabreeka" pads inserted between the engine mounting points and airplane beam fittings. It is secured by eight bolts and nuts arranged in four pairs, through fittings riveted to the inboard side web beneath the top longitudinal beam flange. A propeller reduction gear box is located in the fuselage nose and is bolted to the forward bulkhead. The gear box is connected to the engine by a 10-ft. drive shaft operating at crankcase speed. This shaft runs through the beam fuselage under the pilot's seat and consists of a flanged coupling and center bearing. The reduction gear box has a separate oil system.

The exhaust system is comprised of dual stacks, six on each side, of formed seam-welded stainless steel with sand blast finish. Stacks are welded to mounting flanges for attachment to engine.

### Fuel System

The fuel system consists of two 60-gal. tanks integrally built into the outer wing panels. The left wing tank includes a reserve area of 20 gal. A droppable auxiliary fuel tank of either 75- or 150-gal. capacity may be carried in the bomb rack suspended from the wing center section.

Fuel is supplied to the carburetor by a pressure pump, located on the rear of the engine accessory housing, augmented by either two booster fuel pumps in the wing, or by a single booster pump in the wing center section. Booster pumps are electrically driven and are used for starting, warm weather takeoff and high altitude flying to prevent vapor lock.

Between the booster pump and engine driven fuel pump is a Lunkenheimer fuel strainer, an air vapor eliminator, and air vapor control valve. The latter two are installed to provide a steady flow of fuel when the fuel selector valve is actuated to switch fuel intake from an empty to full tank. A vent line from the carburetor to the left wing tank is routed through the air vapor control valve which prevents vapor in the left wing tank from backing up into the carburetor.

A fuel pressure warning switch, connected to the carburetor and carburetor air intake balance line, is provided along with a light indicator to warn the pilot of fuel pressure conditions.

The carburetor air intake system is comprised of a ramming air scoop, located behind the aft cabin on the airplane vertical centerline, in a straight duct into the carburetor. The forward face of the duct has a door controlled from the cockpit, which closes off cold air and admits warm air from the engine compartment.

A primer pump is installed at the lower right-hand side of the radio control panel. It is hand-operated and draws fuel from the booster pump and injects it into the engine intake manifold system.

### Fuel Tanks

Each fuel tank consists of six leakproof fuel bags. The left wing tank is equipped with two finger-type fuel strainers, one providing for normal fuel consumption, and the other for reserve fuel consumption. The right-hand tank includes only one finger strainer providing for consumption of the entire tank content.

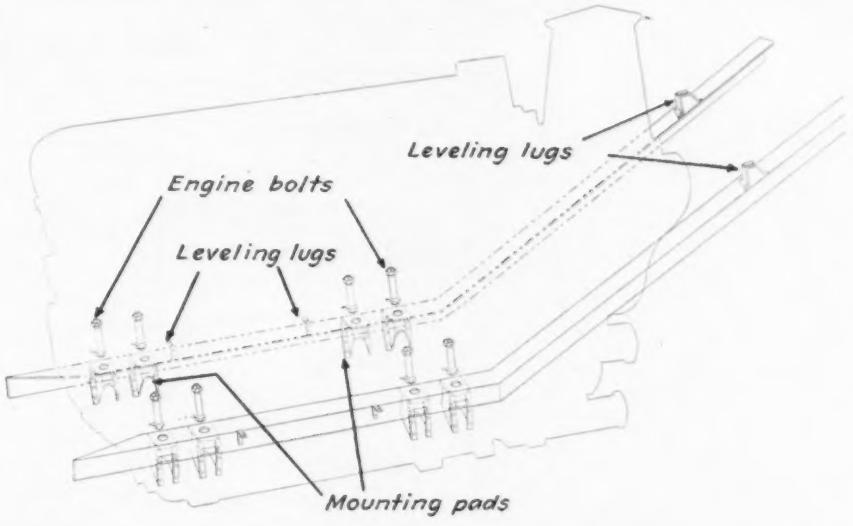
Each tank is equipped with a liquidometer unit with a resistance strip and movable contact arm, at the end of which is installed a pivoting cork float which actuates the contact arm in accordance with the tank fuel level. The contact arm position is transmitted electrically to an indicator graduated in gallons and located on the main instrument panel. Electrical connections are installed within shielded conduits between each tank unit and the instrument panel indicator.

### Fuel Controls

The engine throttle and carburetor mixture control levers are assembled into a single unit (propeller pitch control is also in this unit), mounted on the left cabin wall at the forward door frame. In order to prevent creeping due to vibration, the control levers are governed by a bronze friction adjusting nut which is attached to the quadrant bolt and may be tightened or loosened to permit easy sliding of stiff levers or to allow tightened action of loose levers.

The throttle control lever is located most outboard on the quadrant and governs speed and manifold pressure. Lever knob is equipped with a spring-loaded push button which operates the throat microphone, allowing pilot to operate the radio transmitter without removing his hand from the throttle.

The mixture control which is incorporated with the injection type carburetor has four main control settings, namely, *Full Rich, Automatic Rich, Automatic Lean* and *Idle Cutoff*, in the order mentioned. Carburetor mixture can be adjusted by motion of the lever between *Automatic Rich* and *Automatic Lean* by "click and feel". Automatic altitude mixture control is also maintained for any fixed position of the control lever between *Automatic Rich* and *Automatic Lean.*




**Engine is fastened to forward fuselage** across longitudinal beams and tied down by eight bolts in four pairs and mounted on "Fabreeka" pads.

### Oil System

Engine lubricating oil is circulated by a main pressure pump having a built-in check valve, and a scavenger pump located at the lower right-hand side of the engine accessory housing. Oil is supplied to the pressure pump "In" from the bottom of the tank and circulates through the engine. Oil leaves the engine from the main scavenger pump "Out" and is delivered equally to each of the oil coolers and returns through parallel lines connecting to a single line attached to the top of the oil tank. The propeller reduction gear box is lubricated by a separate oil circulating system with its own tank and pump.

### Engine Oil Tank

The engine main oil tank, of 13.8-gal. capacity, is constructed of seam welded magnesium alloy sheet located in the aft fuselage behind the engine accessory bay on the airplane centerline. Tank oil level is measured by a flexible bayonet-type sound rod located in the tank top casting. It is impossible to fill the expansion space provided within the tank with the airplane in its normal rest position.

### Oil Cooling System

The oil cooling system consists of two oil coolers with separate air ducts located within each outer wing panel and connecting to each cooler in the wing center section. The coolers incorporate an independent, fully automatic, thermostatically controlled by-pass valve which circulates oil along the cooler coil until the oil is properly cooled.

Cooling air enters each duct through an individual opening on either side of the fuselage at the wing leading edge. Each duct leaves the outer wing panel between the wing front and rear beams and joins the section of duct connected to the coolers. Air exhausts through flap-type shutters located aft of the coolers on the underside of the wing center section. Shutters operate in unison by a lever control located on the right forward face of the turnover beam near the cabin floor and can completely restrict air-flow through the coolers.

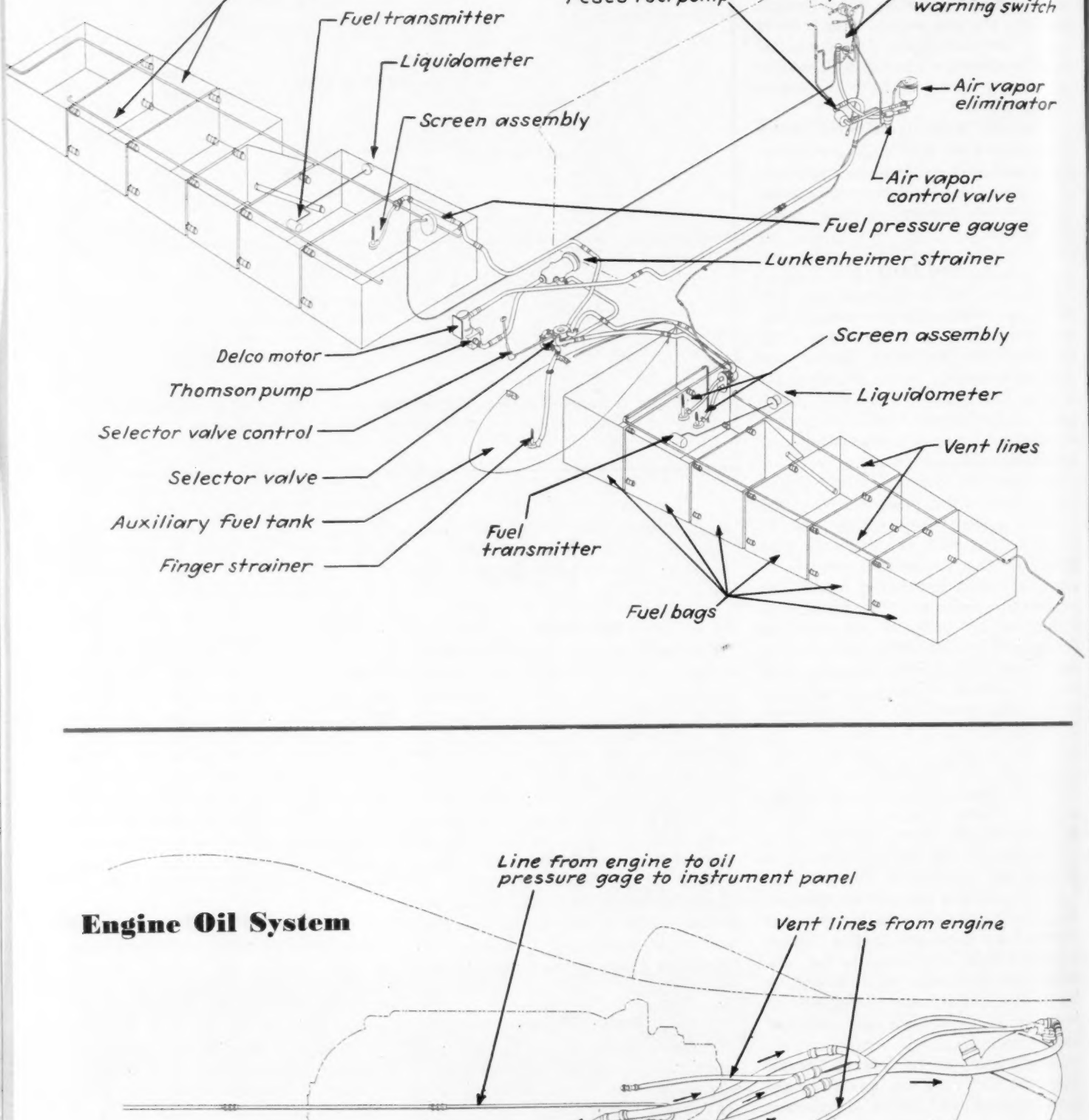
### Oil Dilution System

A solenoid operated oil dilution valve is maintained in the system for cold weather starting. Dilution of oil is accomplished by controlled addition of engine fuel to the oil inlet line by operation of a toggle type switch on the left hand auxiliary switch panel.

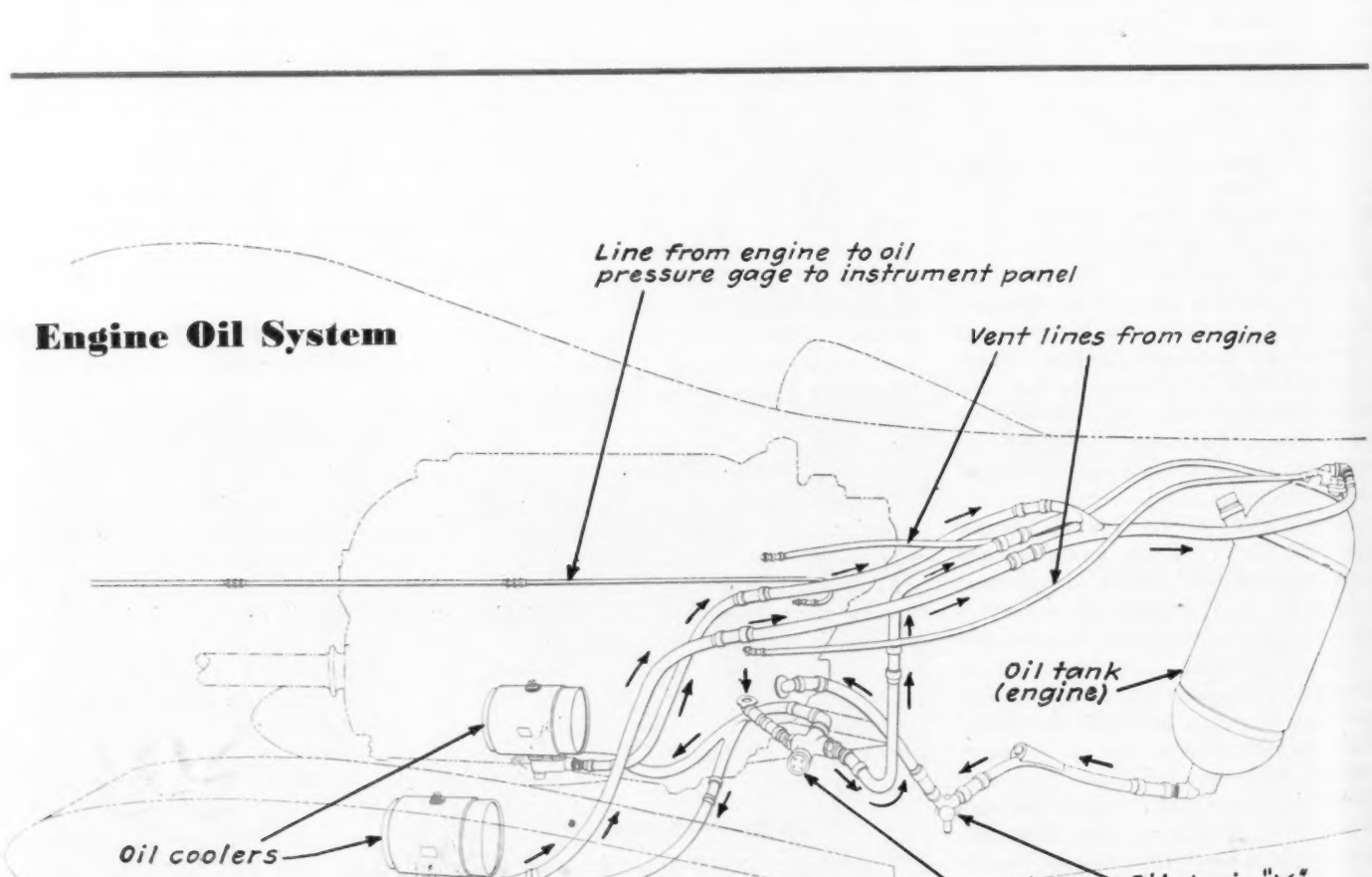
An oil thermometer well is installed in the oil line from the main engine oil tank to the oil drain "Y" fitting. A thermometer bulb connects to the well and runs to the oil temperature gauge on the instrument panel and registers oil "In" temperature.

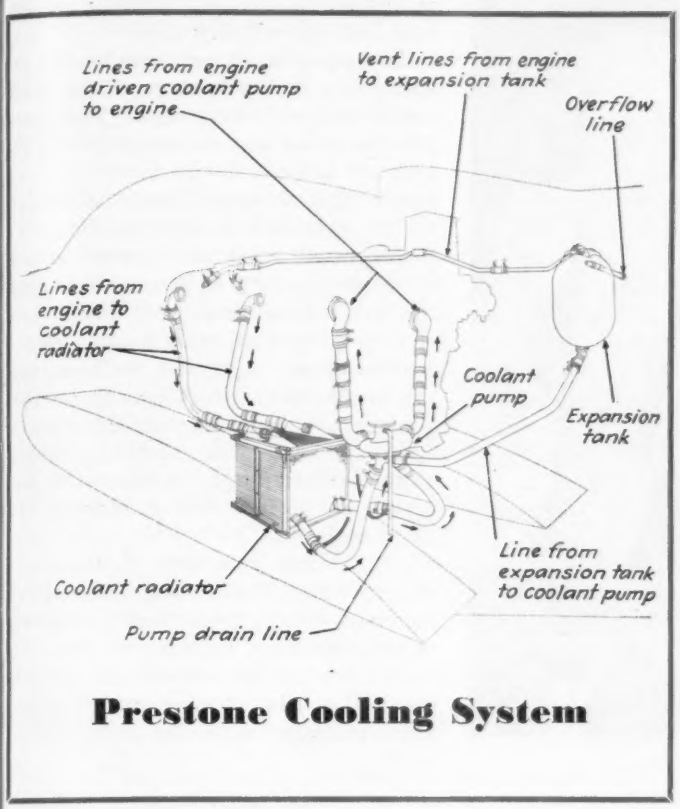
The oil drain Y fitting is located in the right hand side of the airplane in the oil line which runs from the bottom of the main oil tank to the oil pressure pump. The drain Y fitting is in the lowest part of the oil system which can be drained from this point with the airplane at its normal rest position on the ground.

## Fuel System

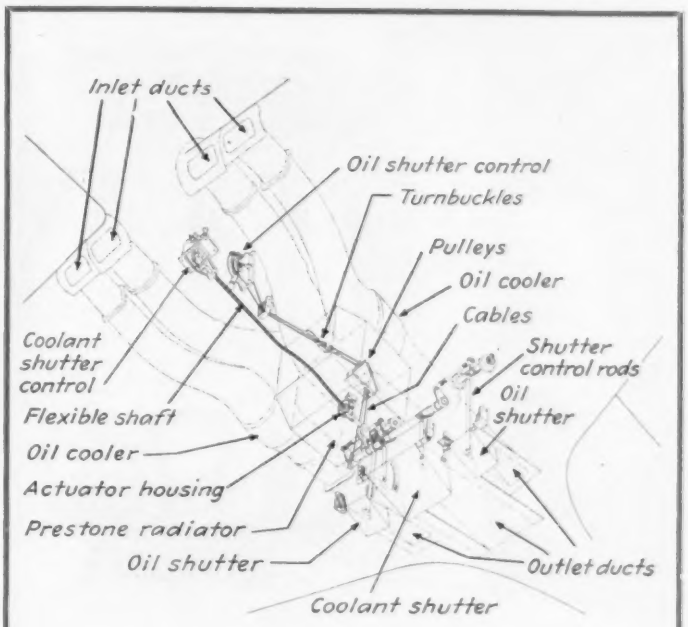



## Engine Oil System


Line from engine to oil pressure gage to instrument panel
Vent lines from engine
Oil tank (engine)
Oil coolers
Oil drain "Y"
Surge valve


Lines from engine driven coolant pump to engine
Vent lines from engine to expansion tank
Overflow line
Lines from engine to coolant radiator
Coolant pump
Expansion tank
Coolant radiator
Line from expansion tank to coolant pump
Pump drain line

**Prestone Cooling System**




**Cooling Air System**

### Surge Valve

A by-pass surge valve is incorporated in the oil system. When the airplane has been idle for any length of time in cold weather, the oil in the coolers become congealed and may cause damage from oil pump pressure when the engine is started. If oil pressure exceeds 60 psi., the surge valve opens, releasing pressure in the coolers and sending the majority of oil flow directly back to the main oil tank. When seepage from the surge valve loosens the congealed oil, the valve closes, allowing oil to flow normally to the coolers.

Two engine breather pipes are connected to the engine, one to the top forward end, and one to the top of the accessory housing. Both breather pipes are routed downward to the bottom of the airplane fuselage and exhaust into the slip stream.

All oil lines are of aluminum alloy tubing with hose connections, nipples and elbows of standard Army Air Force type. A Pesco oil separator is incorporated in the oil system and is mounted on the left-hand deck of the fuselage. The unit contains no working parts and is sturdily constructed of welded sheet aluminum. Pressure gauge connections and tubular bracket mountings are used throughout.

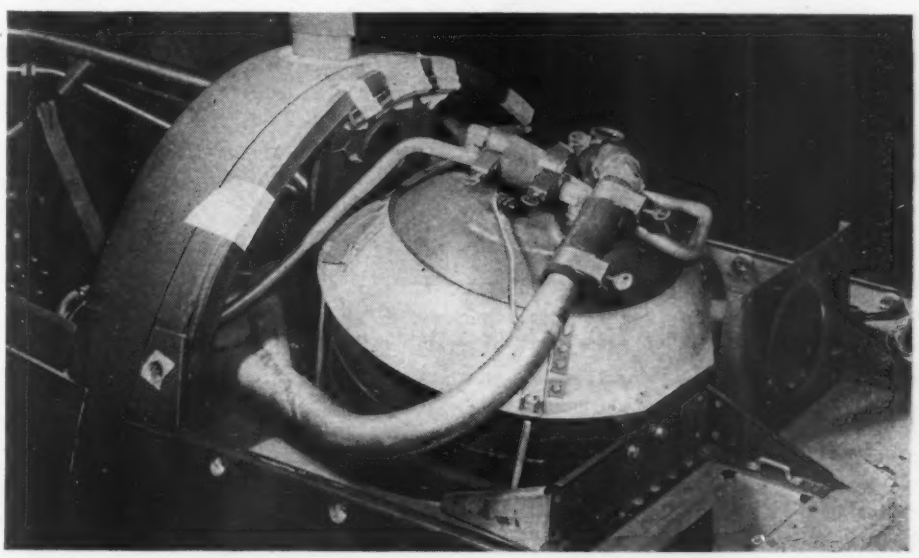
### Reduction Gear Box Oil Tank

The reduction gear box oil tank is constructed of magnesium alloy sheet with welded seams and is located aft of the gear box. Oil pressure lines for this system are aluminum alloy tubing with brass liners at each connection. The line from the gear box to its pressure gauge on the main instrument panel is composed of aluminum tubing, copper tubing and a flexible connection from the line to gage.

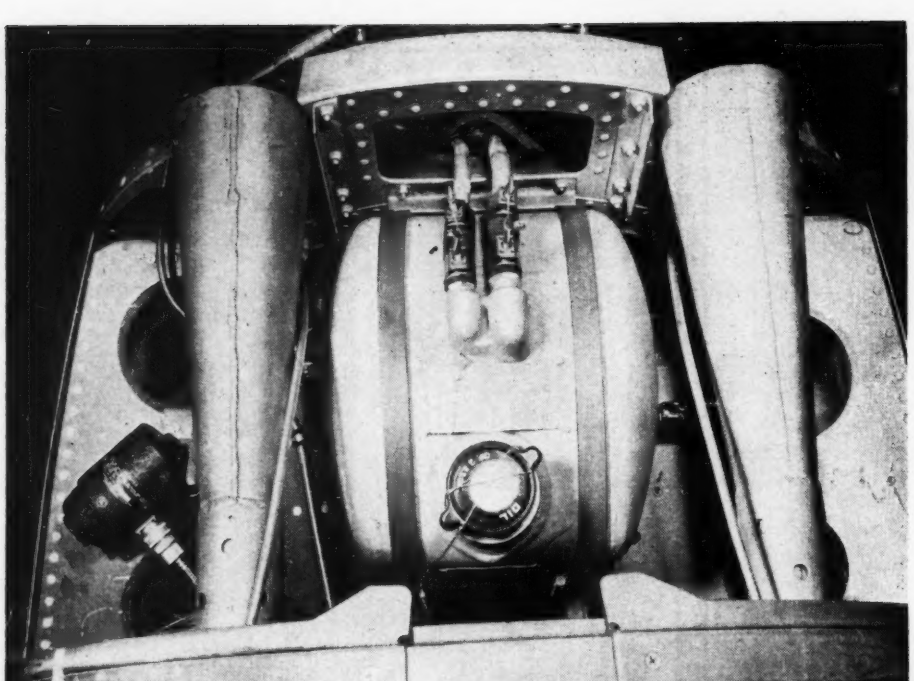
### Cooling System

Engine is cooled by a high-temperature, liquid Prestone cooling system. The Prestone radiator is of the cartridge core type, constructed in two sections and assembled as a single unit in a radiator mounting cradle. The assembly is mounted on four flexible vibration insulating units below the engine, between the longitudinal beams aft of the wing carry-thru rear beam. Coolant is carried in lines from the outlet on the top forward end of each cylinder head to the radiator. Coolant enters the radiator through a compound inlet on each side of the radiator top and flows downward and rearward returning to the coolant circulating pump inlet collector.

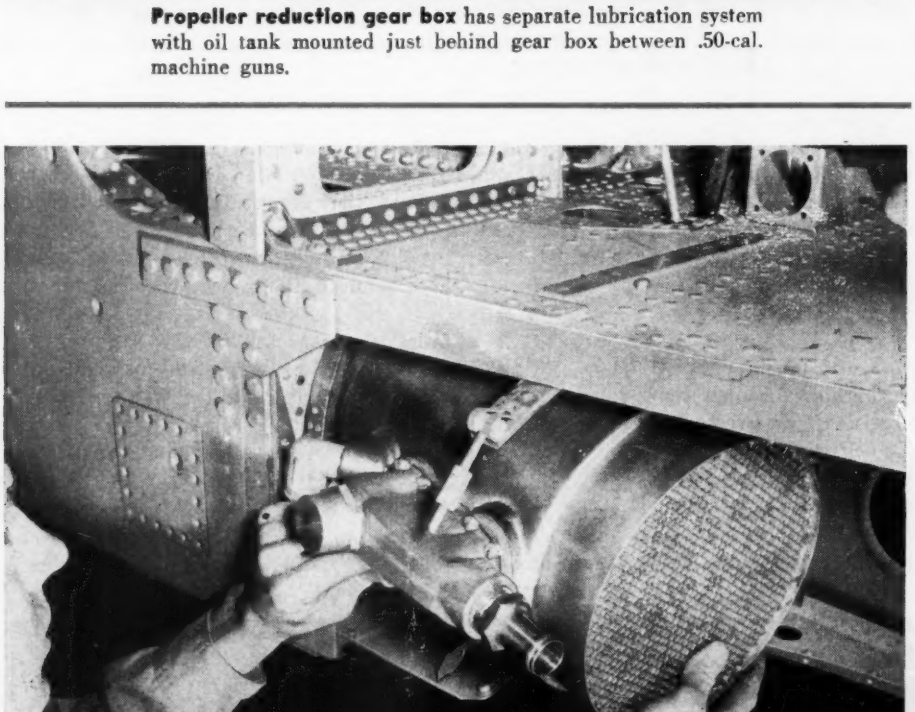
The Prestone expansion tank is so arranged that when filled to the level of the filler neck, when the airplane is in its normal rest position, it will contain the proper amount of coolant, and the



**Engine oil tank** is mounted in aft fuselage structure just behind engine compartment.



**Propeller reduction gear box** has separate lubrication system with oil tank mounted just behind gear box between .50-cal. machine guns.



**Cylindrical oil radiators** mounted in aft portion of wing center section and secured by straps.

proper amount of expansion space. The system is vented to automatically prevent air locks, allow the expansion of coolant, relieve coolant pressure beyond 3 lb., and permit re-entrance of air after coolant temperature drops. The automatic relief and sniffle valves are included in the cooling system filler unit located on top of the tank.

Coolant circulation pump is of centrifugal type and forms a part of the engine. It is mounted on the bottom of the engine accessory housing on the rear left side of the engine.

Two separate air ducts are located on either side of the fuselage at the wing center section leading edge. The ducts flow rearward and converge directly in front of and connect to the coolant radiator with an airtight seal. Radiator shutter control is located on the cockpit floor just below and forward of the oil shutter control consisting of a gear box with a small handcrank which turns clockwise to close, and counter clockwise to open. A flexible shaft extends aft, inside the fuselage beam to a screw actuating a trunnion on the shutter operating arm. The shutter is located at the air exit of the radiator and can completely restrict airflow through the radiator.

All coolant lines are of aluminum alloy tubing. Coolant temperature thermometer well is permanently installed in the right-hand coolant line from the engine top to the radiator to measure the coolant "Out" temperature. Temperature indicator is on the main instrument panel.

### Electrical System

The electrical system is of the single conductor type, shielded and protected by rigid and flexible conduits. A main electrical control switch panel is rigidly mounted to a metal box for shielding and is located to the left of the cockpit main instrument panel.

A standard a.c. type battery is mounted in the forward fuselage between the .50-cal. fuselage guns and beneath the gun compartment cowling, aft of the reduction gear box. It is provided with one drain and one vent to which acid-proof rubber tubing is attached by hose clamps. Battery fumes exhaust into a glass bottle containing a pad saturated with a solution of bicarbonate of soda to counteract the acid. The bottle is vented to the airplane slipstream.

Conduit is provided for the dual purpose of protecting the electrical system and providing electrostatic shielding. Rigid conduit is supported and grounded to the airplane, and flexible conduit is used where flexibility is required. Standard type plugs, connectors, connector plugs, socket assemblies and fittings are used for connecting conduit where disconnection of the electrical system is necessary to remove assemblies. A ground wire is attached to the landing gear nose wheel fork on some models, but on others a special static conducting tire is installed for grounding purposes. The main fuse panel is located on the left hand side of the landing gear nose wheel well within the forward fuselage. Fuse capacity and identification are marked inside the box lid and spare fuses are carried in the fuse box.

### Engine Starting System

Electrically operated, inertia type engine starters are used on *Airacobras*, mounted near the bottom right hand side of the engine accessory housing. A starter pedal is located on the right hand side of the cockpit floor. To energize the starter, the pedal is pressed rearward with the heel. It is held in this position until starter is energized sufficiently to rotate the engine and then the pedal is depressed forward with the toe to engage the starter with the engine. A handcrank is provided and installed in a compartment within the right wing trailing edge. The handcrank extension shaft and sleeve is permanently installed and has a bronze bearing support within the fuselage. It is accessible through a hinged door located on the right hand side of the fuselage near the wing trailing edge.

On some models a mechanism is included for lifting the starter brushes to prevent generation of a charge while the starter is being energized manually. A lever, located in an access door next to the starter door, is operated when the handcrank is being used. When the starter is engaged and the engine started, the lever is operated to return the brushes to their normal position. There is an electric plug located in the left-hand wing trailing edge fillet which may be used in conjunction with an outside battery for cold weather starting. The plug is connected to the electric inertia starter mechanism.

### Generator and Booster Coil

An engine-driven generator is mounted on the engine accessory housing to the rear. The generator control panel is mounted on vibration absorbing units and is installed in a structural enclosure within the left side of the fuselage. A generator relay is operated by a toggle switch on the main electrical control panel.

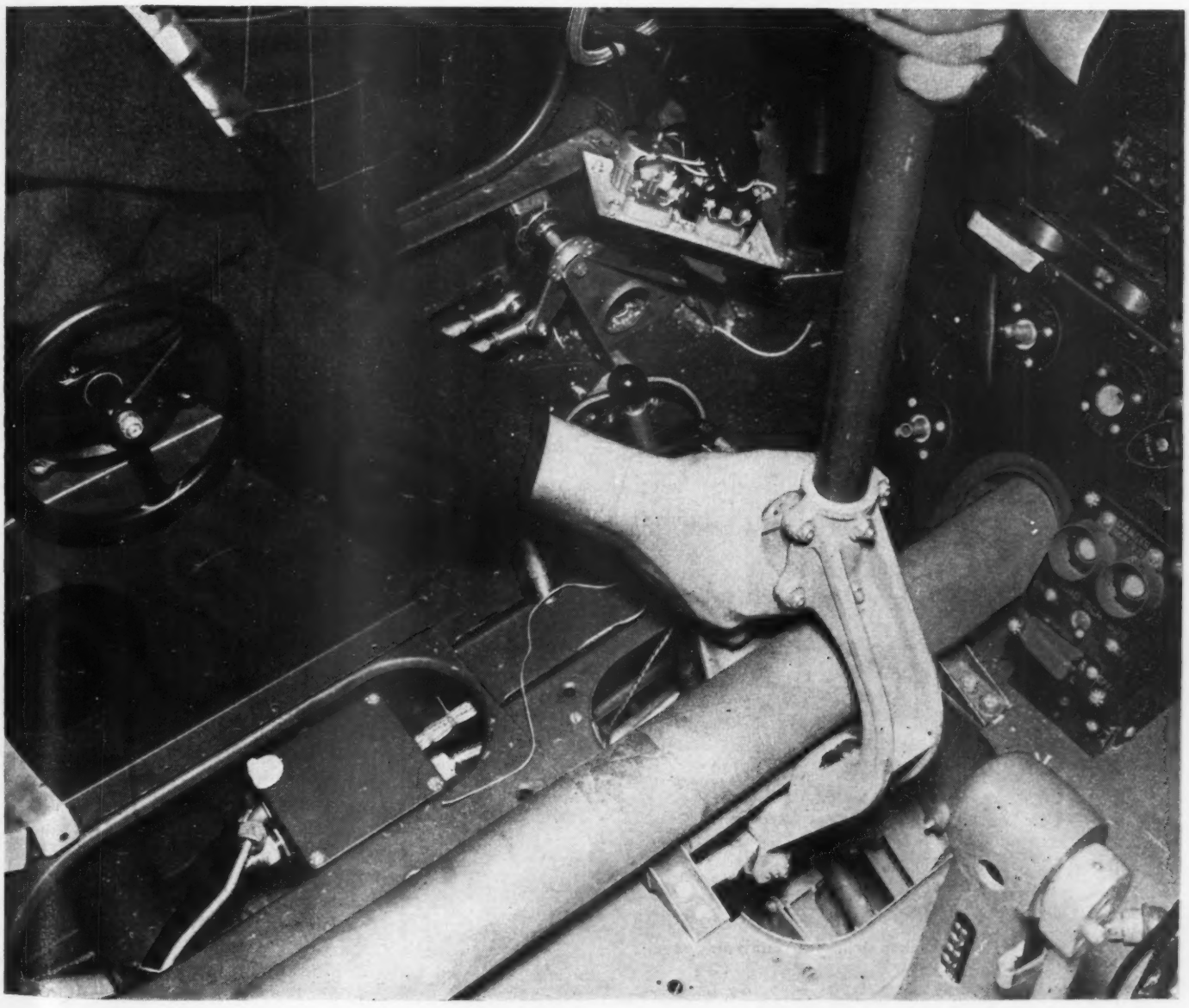
A battery-operated booster coil unit is mounted in a shielded box on the right-hand inclined deck aft of the engine within the fuselage. The circuit is connected so that the coil is energized when the foot pedal starter switch is depressed forward to the engaged position, bringing the solenoid operated starter meshing mechanism into operation.

Current is carried from the booster coil to the right hand distributor by a high tension lead. The solenoid-operated starter meshing mechanism is mounted on the starter.

### Landing Light

A three-focus electric retractable landing light assembly is installed flush with the lower surface of the left-hand outer wing panel. It can be lowered and stopped at any intermediate position or

**Control column is attached to yoke through which passes the propeller drive shaft from engine behind pilot.**



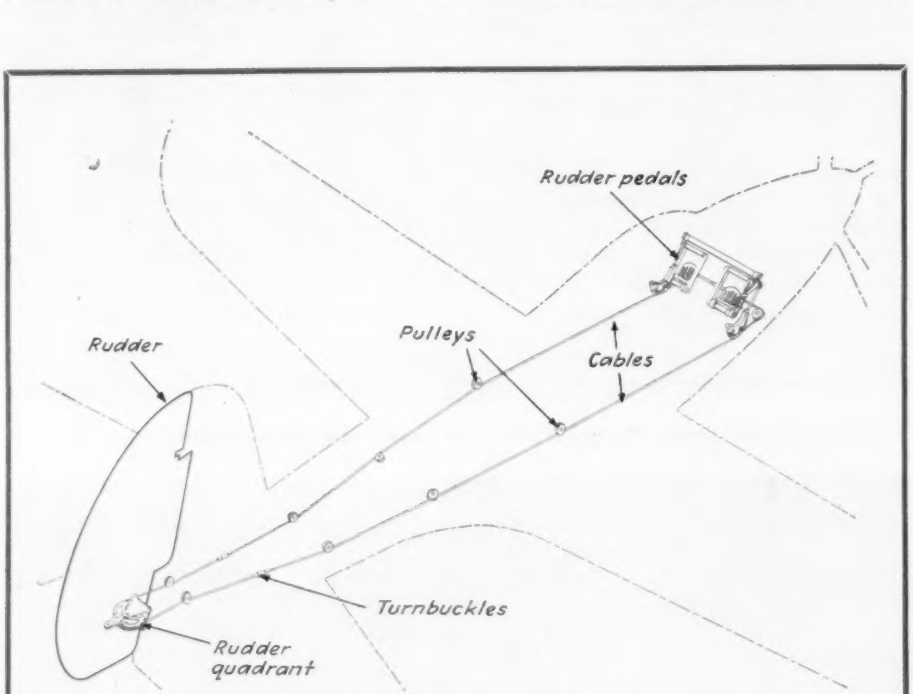
retracted by means of an electric motor controlled from a switch on the main control panel. A cutoff switch is provided on the unit which automatically stops the motor when the light reaches its maximum extended or retracted position.

### Heating and Ventilating System

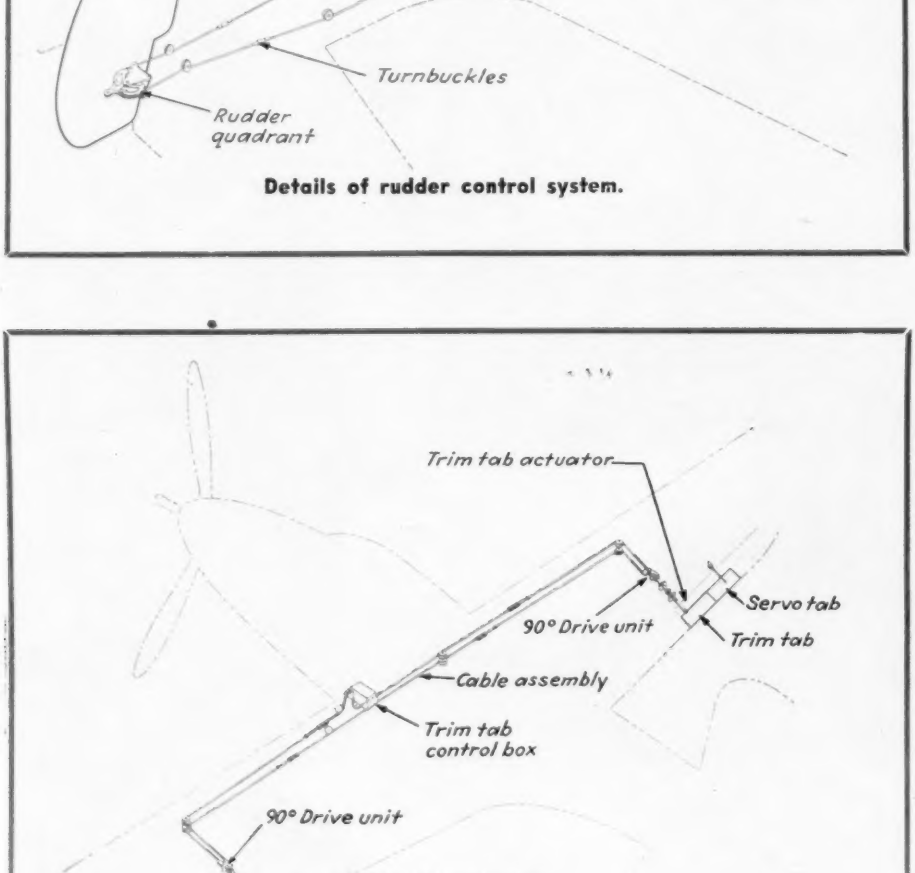
The cabin is heated by two 3-in. metal tubes which take hot air from directly behind the Prestone radiator, and expel it to two ducts on the cabin floor beneath the pilot seat. The hot air duct extends between the engine and fuselage longitudinal beams. Cool air is supplied to the cabin by two ducts which take air from the Prestone cooling duct just forward of the radiator. Cool air is emitted to the cabin through the same ducts as the hot air. Selection of hot and cold or mixed air is controlled by two butterfly flaps, one of which is located on each duct Y at the union of each hot and cold air duct. Two L-shaped handles, located adjacent to each other on the floor to the right of the pilot seat operate the butterfly flaps.

Air is exhausted from the cabin through ducts over the rudder pedal well. These ducts lead to the cannon and .50-cal. machine guns. The air supply to the cabin is constant and only temperature may be regulated. Because of this, there is greater air pressure in the cabin than in the gun compartment, thus preventing fumes from the gun compartment entering the cabin.

The two flexible heater tubes emerging into the gun compartment extend upward and join together at a duct attached to the pan and feed chute assembly of the .50-cal. guns. This duct has two flanged outlets which heat the guns. The forward end of the duct extends downward and to the left and tapers out fan shaped for heating the cannon installation.




**Details of rudder control system.**




**Aileron trim tab control system.**

### Vacuum System

A vacuum pump is mounted on the rear of the engine and is used for forming a vacuum essential for operation of certain instruments. Pump includes a suction line from the instrument panel and an exhaust line to the Pesco oil separator. A relief valve is mounted on top of the vacuum pump to prevent over exertion of suction on the instruments.

A suction gauge mounted on the instrument panel records vacuum suction in the lines. An air filter is included with the vacuum system and is mounted on the left hand forward inclined deck beneath the gun compartment cowling. This unit is maintained to remove any minute particles from the air that might become injurious to the mechanism of the instrument.

### De-icing Equipment

De-icing equipment includes a glycol spray to prevent formation of ice on the windshield and a propeller blade de-icing installation. Both units are supplied from a single glycol tank mounted in the gun compartment of the forward fuselage.

The windshield de-icing equipment consists of a hand pump located on the right-hand instrument panel, a nozzle assembly on the windshield, and a de-icing rheostat, also on the right-hand instrument panel. When the pump is operated, a glycol fluid is drawn from the bottom of the glycol tank and is pumped to the windshield nozzle assembly located just above the windshield armorplate. The nozzle is curved to the windshield contour and is profusely punctured to facilitate several streams of fluid to be ejected upward on the glass.

Propeller de-icing equipment consists of an electric-driven Adel pump with a filter, a nozzle assembly, a propeller slinger ring (included with the propeller assembly), and a control switch on the right-hand instrument panel. When the control switch is turned on, the electric motor pumps fluid from the glycol tank. The fluid passes through a filter before entering the pump and is sent forward to the slinger ring which splashes it onto the blades.

## Surface Control System

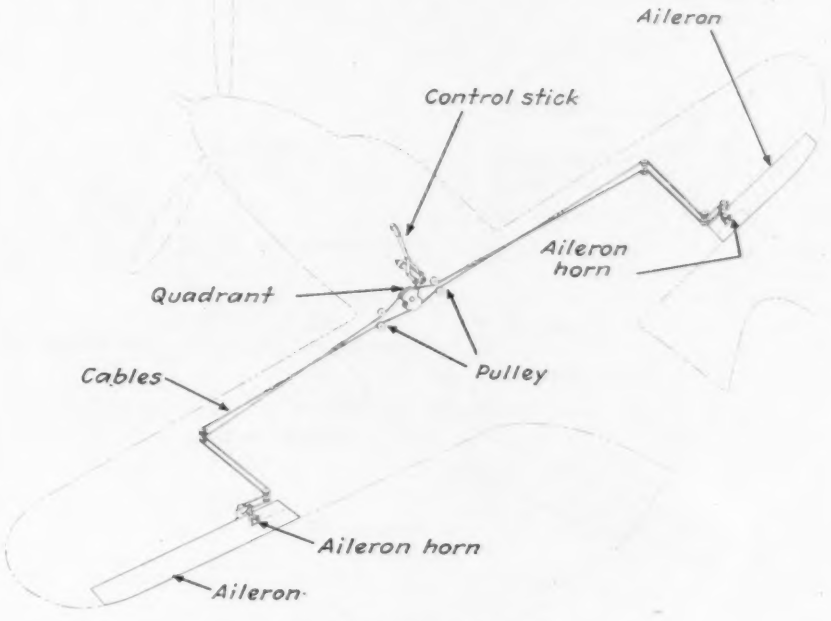
The control system of the Bell P-39 *Airacobra* is of the stick type, the control column attached to a yoke at the cockpit floor through which the engine-drive shaft runs from behind the pilot to the propeller reduction gear box. Control column travel is regulated by four stop bolts, two of which are located so that they contact the aileron lever (regulating lateral movement), and two located to contact the yoke bottom (regulating fore and aft movement). Rudder pedals are adjustable in five positions ranging from 3¼ in. forward to 3¼ in. aft of the 90 deg. setting. They are adjusted by two levers, one located outboard of each pedal. These foot-operated levers are spring loaded and release a pin from a stop when depressed. The main control cables are constructed of extra flexible corrosion-resistant steel and the control cable pulleys are of the anti-friction, ball bearing type.

### Elevator and Aileron Controls

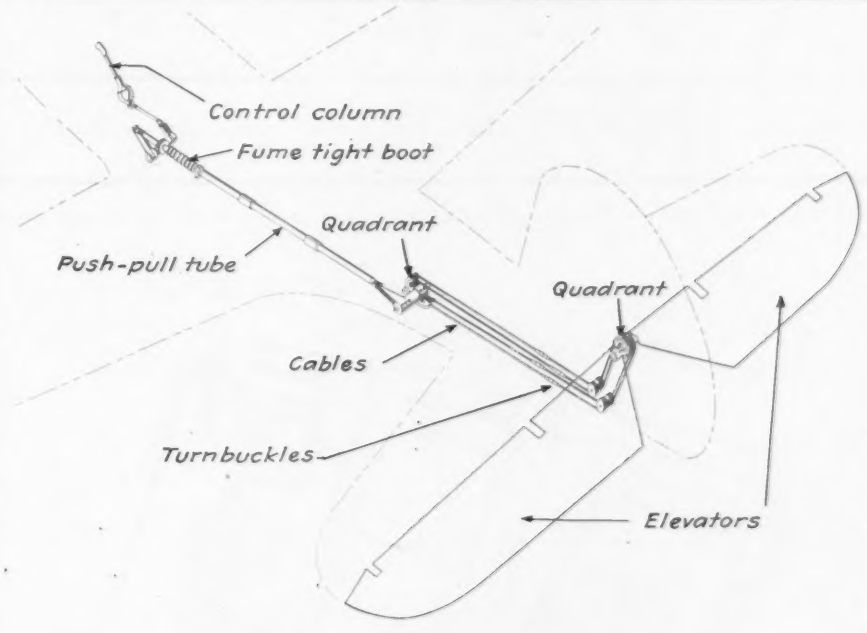
Elevators are controlled through a push-pull tube assembly attached to the bottom of the control column yoke and running back through the fusleage to a quadrant in the aft fuselage section. From this point, a duplicate cable system (four cables in all) extend along the lower aft fuselage, around a set of pulleys at the extreme rear, and upward to the elevator control quadrant at the elevator splice bar.

The aileron lever on the control column actuates an aileron link rod connected to a quadrant in the fuselage. Control cables run outboard from this quadrant along the leading edge of each outer wing panel. At wing Sta. 7.5, the cables make a 90-deg. turn aft and run to a quadrant located on the forward side of the wing auxiliary beam. The quadrant actuates a linkage assembly that connects to a fitting on the aileron leading edge.

Rudder control consists of two link rods connecting the rudder pedals to two quadrants in the center section of the fuselage. Control cables are connected to these quadrants and extend aft through the fuselage, guided and supported by pulleys, to the rudder con-



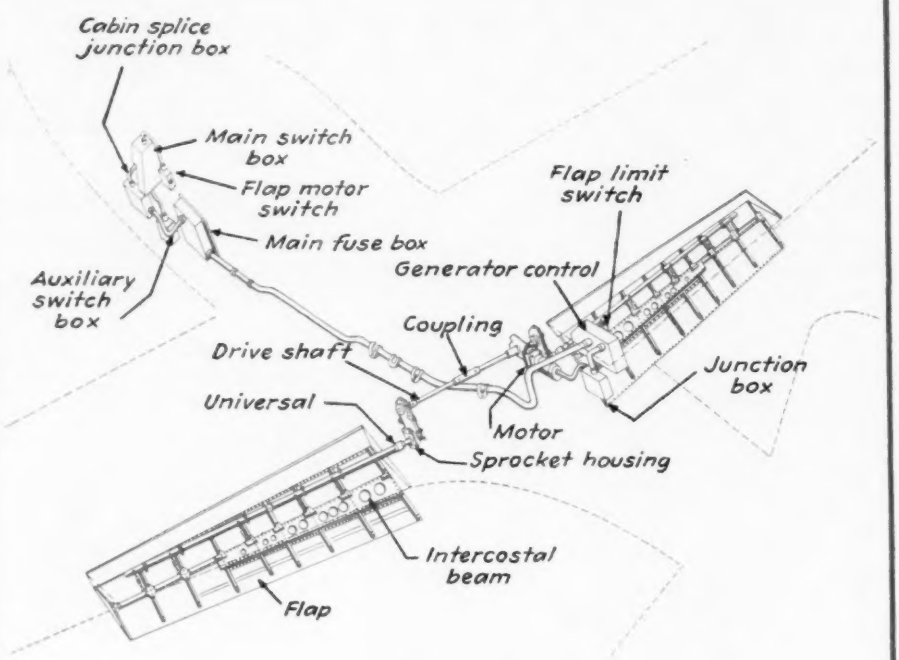

**Aileron control system.**



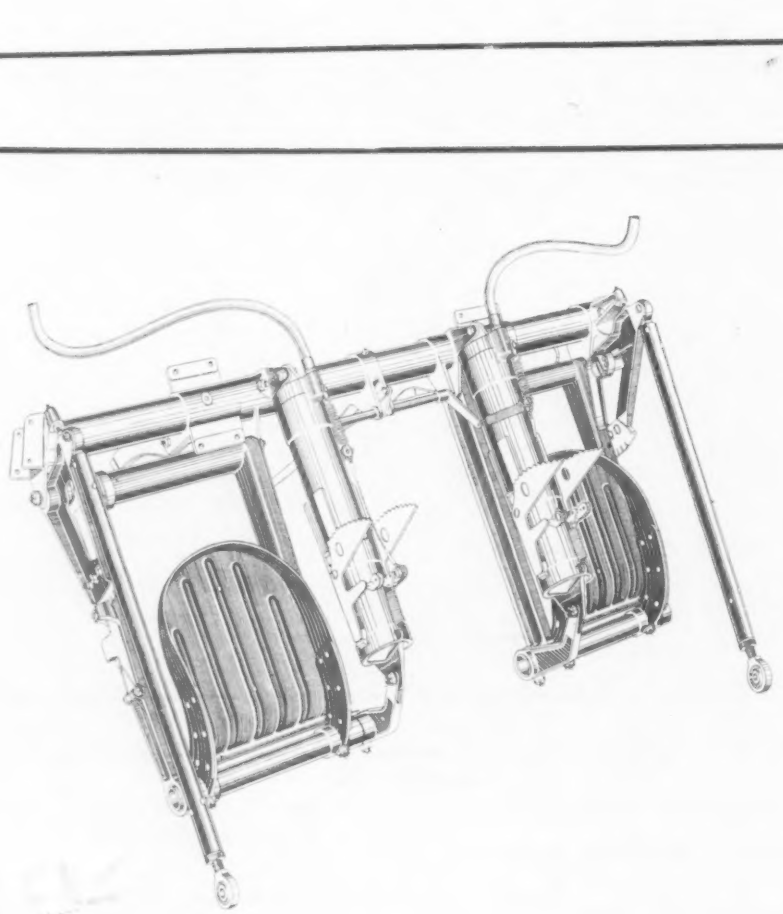

**Elevator control system.**

**Control Travel**

| | |
|---|---|
| Control column neutral position | 8 deg. 15 min. fwd. of vertical and 90 deg. to cockpit floor |
| Control column travel—forward | 13 deg. 20 min. |
| —aft | 31 deg. 0 min. |
| —lateral | 20 deg. 15 min. right or left |
| Elevator travel—above netural | 35 deg. |
| —below neutral | 15 deg. |
| Rudder travel | 30 deg. right or left |
| Aileron travel—above neutral | 25 deg. |
| —below neutral | 10 deg. |
| Elevator trim tab travel—up or down | 15 deg. or 20 deg. |
| Rudder trim tab travel—left or right | 15 deg. or 20 deg. |
| Aileron trim tab travel—up or down | 10 deg. |




**Landing flap controls powered by ½-hp. electric motor.**



**Details of rudder control pedals showing hydraulic brake pistons.**

trol quadrant on the rudder main beam.

### Flap Control

Flaps are actuated by a ½-hp. electric motor, located on the fuselage deck underneath the right wing fillet, and controlled by a toggle switch in the cockpit. The motor operates two sprocket housings, one located immediately inboard of each wing splice. The right-hand sprocket housing is connected directly to the motor assembly by means of a drive shaft running through the fuselage. Sprocket housing is attached on the outboard side to the flap mechanism consisting of a universal joint, a housing, a screw, a push-pull tube, and five turnbuckles. The universal joint attaches to a splined shaft of the sprocket housing and connects to the screw assembly which operates the push-pull tube. This tube rolls along on five roller assemblies attached to the wing auxiliary beam. Turnbuckles form the connecting links between the push-pull tube and flap. Limit switches stop the flap motor when the flaps are completely up or down. If limit switches fail to work, a friction clutch, which is part of the motor and adjusted to slip at an output torque, at slow speed shaft, of 110 in.-lb., will stop the motor.

### Trim Tab Controls

Trim tabs are located on each aileron, the rudder, and left-hand elevator. Separate control knobs for all three are located on the cockpit floor to the left of the pilot seat and each is marked in degrees.

A sprocket-driven chain from the elevator trim control unit is connected by turnbuckles to control cables which are supported by pulleys and run aft through the fuselage. The cables are connected to a straight drive unit. A flexible drive shaft runs from the straight drive unit to the trim tab actuator installed on the left-hand elevator beam.

To the aileron trim control is connected a sprocket-driven chain connecting to control cables at the wing leading edge near the wing splice. Cables run outboard in the leading edge of each outer wing panel to wing Sta. 7.5 where they make a 90-deg. turn aft and continue to the wing auxiliary beam. At this point cables attach to a chain which operates a sprocket drive unit mounted on the forward side of the auxiliary beam. A flexible drive shaft connects the sprocket drive unit to the actuator mounted on the aileron main beam.

A sprocket-driven chain runs from the rudder trim control to a point just aft of the fuselage turnover beam where it is connected to control cables which run aft through the fuselage and connect to a chain in the aft fuselage. This chain actuates a 90-deg. drive unit

which connects to the trim tab actuator on the aft face of the rudder beam through a flexible drive shaft.

## Armament

The Bell P-39 *Airacobra* armament consists of a 37-mm. cannon located on the fuselage centerline just above the extension drive shaft with the gun barrel projecting through the reduction gear box and propeller hub; two .50-cal. Type M-2 machine guns installed in the forward fuselage just ahead of the pilot and synchronized to fire through the propeller are; four 30-cal. free firing machine guns installed in pairs in each outer wing panel.

Cannon and machine guns are manually charged and electrically fired by solenoid units actuated by two firing switches on the control stick, one for the cannon and the other for machine guns. The .50-cal. guns are equipped with flame suppressor blast tubes. An impulse tube type synchronizer is used on these guns, the tubes fabricated from chrome moly steel and clamped to the gun barrels at approximately 12-in. intervals. Exhaust louvres are installed in the gun compartment cowling to evacuate fumes.

Each .50-cal. gun has a separate ammunition case containing 200 rounds. Ejection chutes are provided to carry off links and cases. Both chutes deposit their contents into a triangular space between the longitudinal beams and outer skin.

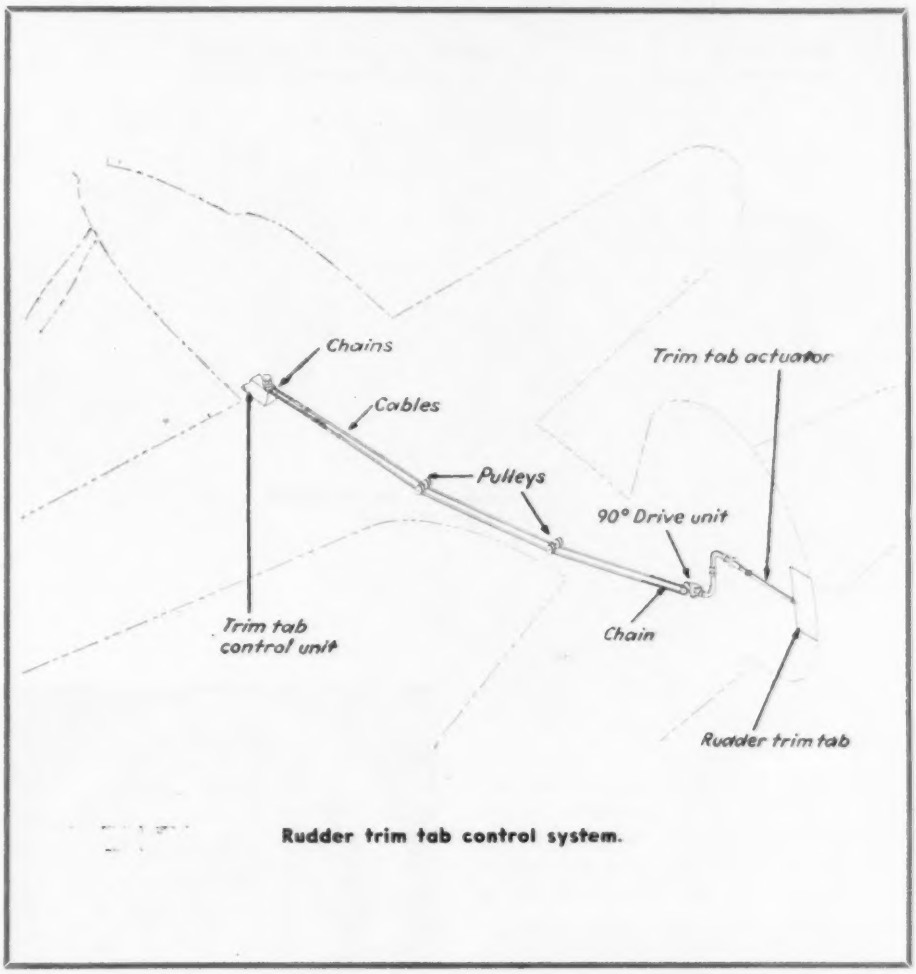
Each set of .30-cal. guns has an ammunition box located outboard of the guns between the front and rear beams. Boxes contain 1,000 rounds, 700 of which are considered alternate load. Ejection chutes are installed for wing guns, the links dropping inboard from their respective guns and the cases dropping straight down. Four small doors on each lower wing surface eject the contents into the slipstream.

The 37-mm. magazine is a circular endless belt type installed around the cannon and containing 30 rounds. An ejection compartment for links and cases is located between the longitudinal beams' web and outer skin.

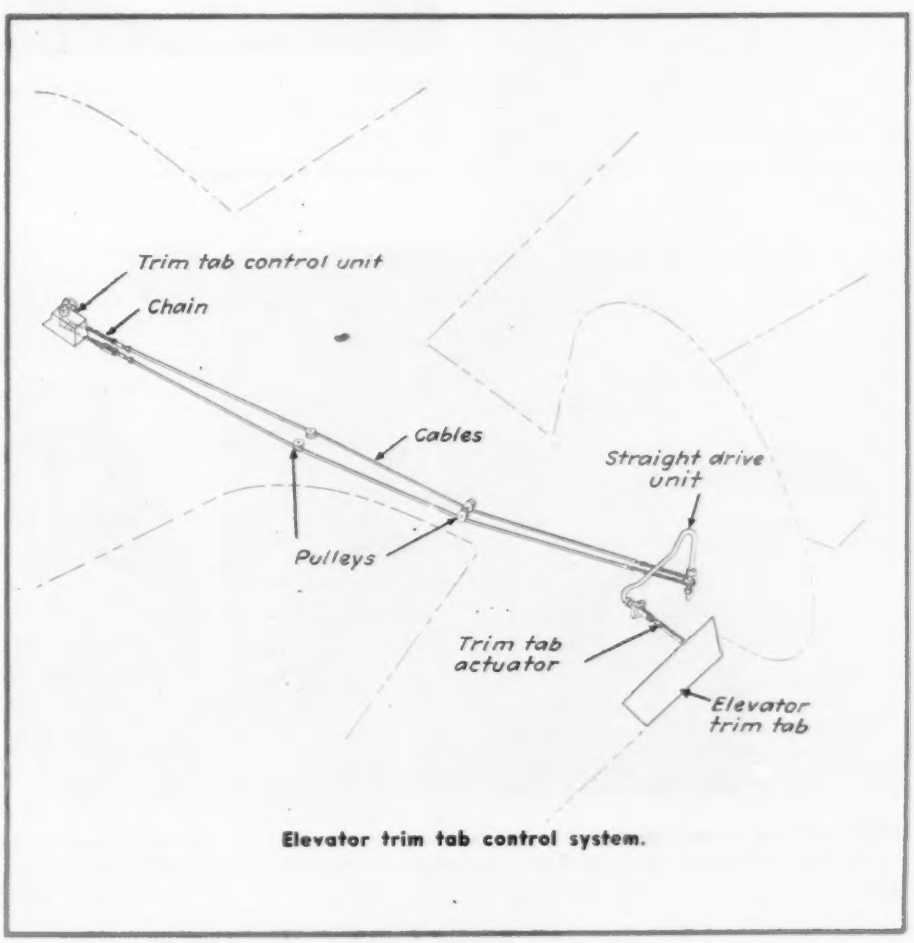
## Armor

A considerable amount of armor is installed at vital points on these airplanes. Homogenous steel plate, face-hardened steel plate, and bullet-proof glass are used.

Armor plate at the propeller reduction gear box consists of 5 pieces of $\frac{3}{8}$-in. homogenous steel and completely protect the gear box from frontal fire. The fume-tight bulkhead armor plate between the pilot and gun compartment is fastened to the forward side and is a

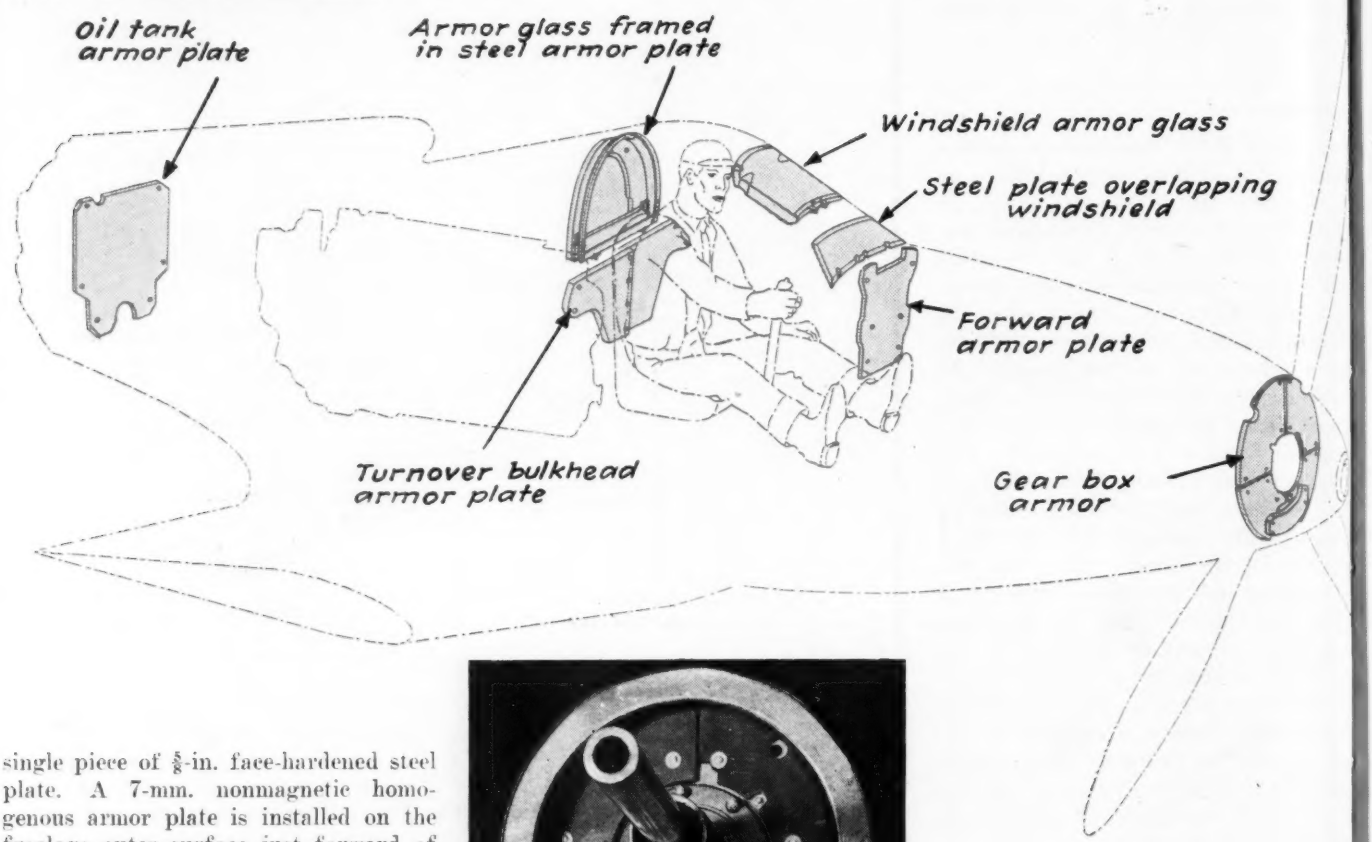



**Rudder trim tab control system.**




**Elevator trim tab control system.**

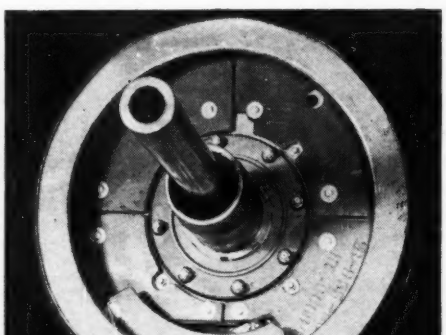
## Armor Installation


Oil tank armor plate
Armor glass framed in steel armor plate
Windshield armor glass
Steel plate overlapping windshield
Forward armor plate
Turnover bulkhead armor plate
Gear box armor

single piece of $\frac{5}{8}$-in. face-hardened steel plate. A 7-mm. nonmagnetic homogenous armor plate is installed on the fuselage outer surface just forward of and overlapping the lower part of the windshield.

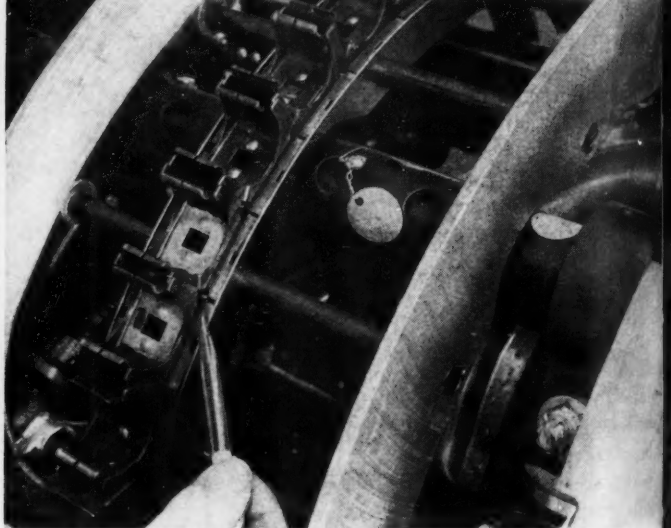
The turnover bulkhead armor plate consists of two pieces of $\frac{1}{4}$-in. face-hardened plate fastened to the aft side of the turnover beam immediately forward of the engine. Both sections extend inboard from the beam and overlap each other one inch. They are bolted together at the overlap. A body turnover armor plate consists of two pieces of $\frac{1}{4}$-in. face-hardened plate bolted to the aft face of the turnover bulkhead. The plate is of a general horseshoe shape and fits around the aft armor glass, giving pilot full rear protection. A $\frac{1}{4}$-in. face-hardened plate is bolted to the bulkhead just aft of the oil tank and is designed to protect this tank.

The forward armor glass is $1\frac{1}{2}$ in. thick and is located above and forward of the gunsight in the cabin. It is

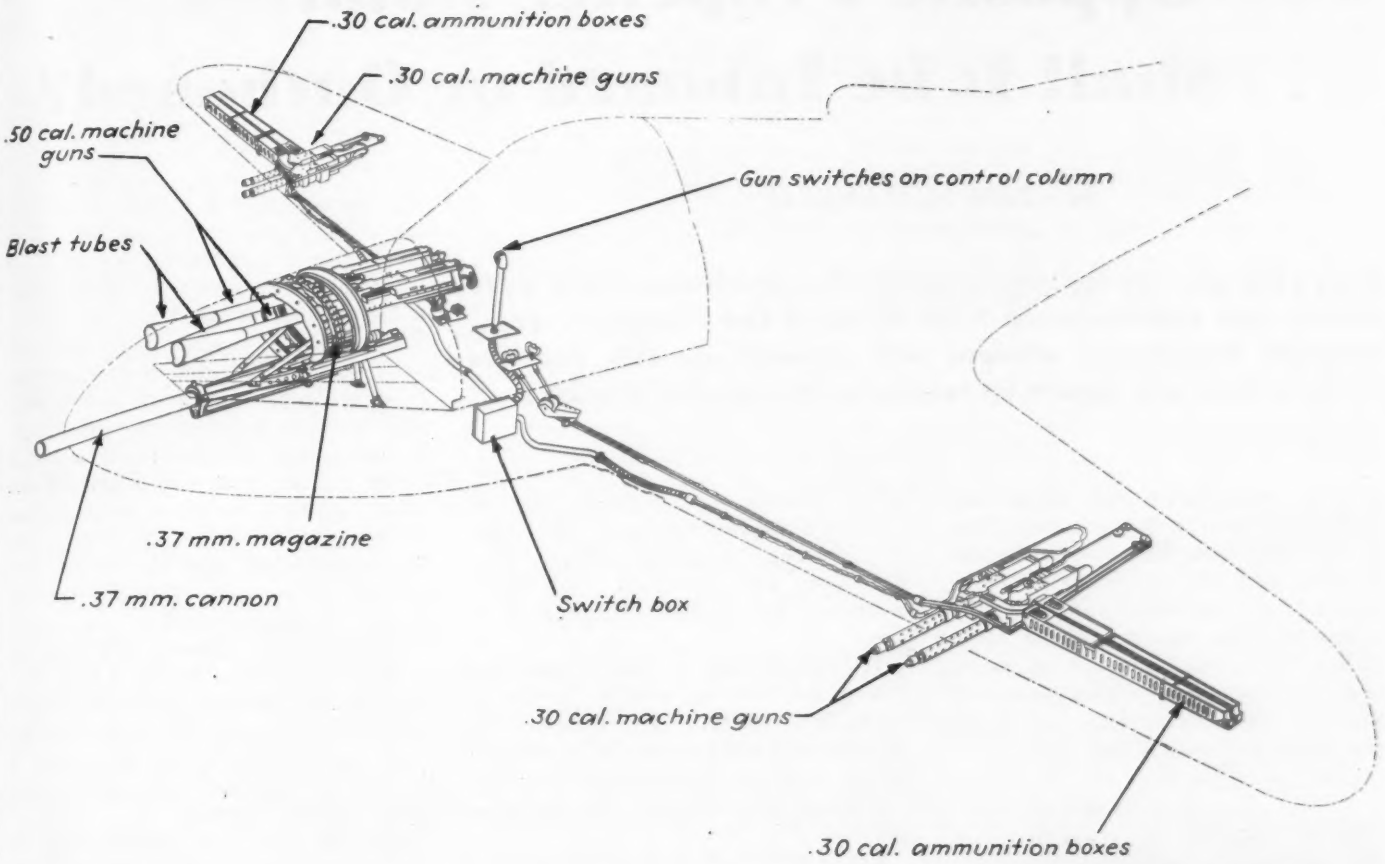


**Close-up** of $\frac{5}{8}$-in. homogenous steel armor plate installation protecting reduction gear box.

**Pilot bulkhead armor plate** is $\frac{5}{8}$-in. face-hardened steel while windshield overlapping plate is 7-mm. non-magnetic homogenous plate.



**Circular endless belt-type magazine** for 37-mm. cannon is 30-round capacity and is located around .50-cal. gun barrels. Shell clips are shown here in detail.

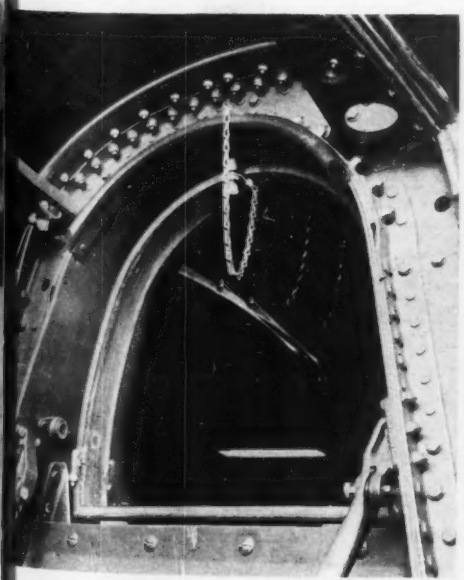



mounted at the bottom of the gunsight support casting and at the top of the transverse windshield frame. In conjunction with the armor plate at the lower outside windshield, it protects the pilot from frontal fire.

Aft armor glass is 2½ in. thick and is located in the curve of the fuselage turnover beam aft of the pilot. It is held securely in place by a jamb nut and dovetailed screw which fastens to the top inside curve of the turnover beam.

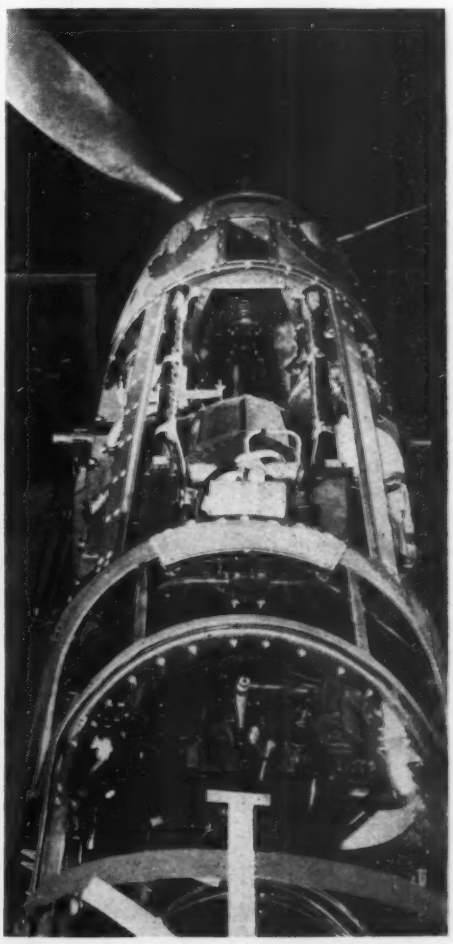
**Acknowledgement**

The foregoing description of the Bell *Airacobra* was made possible with the generous assistance and cooperation of the Bell engineering department, particularly Mr. Harland M. Poyer, Martin W. Haney, and Marvin M. McEuen.



**Aft armor glass** located in turnover bulkhead behind pilot is 2½ in. thick.

**Magazine boxes** for .50-cal. ammunition located just forward of cabin bulkhead.



**View of fuselage gun** installation showing how .50-cal. guns protrude through cowl. These guns are synchronized with propeller.

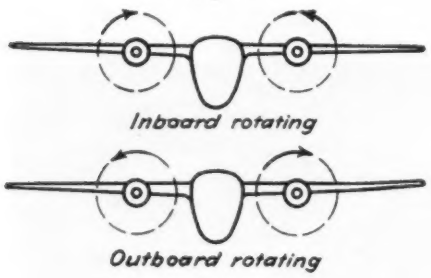
# Opposite Propeller Rotation . . . Shall It be Inboard or Outboard?

By JEAN H. HAMELET,
*Pilot for Consolidated Aircraft Corporation*

**What's the case for opposite rotation? And which direction is best? Initially, this question arose in the design of fast twin-engine ocean warships. Comparable problems with airplanes are ably discussed by the author, who reports his rotation preference for aircraft.**

MOST ARGUMENTS end where they should have begun—in definitions. In this discussion on opposite rotation of right and left propellers on multi-engine planes, we will consider direction of rotation in relation to the upper blades, with right and left as viewed from the rear. The terms inboard and outboard, as illustrated in Fig. 1, are unchanged by front or rear view.

Fig. 1




The general desirability of opposite rotation is fairly obvious, since by this means engine torques are balanced against each other, whereas in single direction rotation they are added to each other. The question of deciding between inboard or outboard direction in opposite rotation can, however, bear further investigation. Governing factors in any decision on the whole problem are production and maintenance costs, balanced against advantages of performance.

The two types of propellers and reduction gears necessary for opposite rotation raise definite complications. Further research on the matter of performance may offer compensations in future practice.

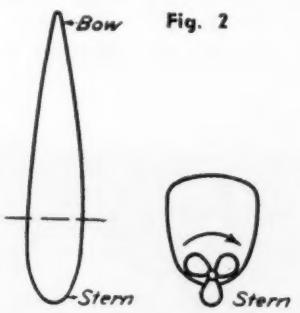
In analyzing the question of best performance, it may be profitable to review the closely related problems which arose with the first twin-engine destroyers built to plow the seas about the beginning of the century. These were designed with both propellers turning in the same direction.

After some experience with them, the need for opposite rotation was recognized. But for years argument went on between naval engineers as to what solution was best. Eventually, one solution prevailed, and now all twin-engine destroyers have outboard propeller rotation.

It is interesting to observe here that this is not the best solution as far as speed is concerned. The decision was imposed by considerations of maneuverability, and the same compromise holds for airplanes, although for different reasons.

Lower blades of surface-ship propellers exert more push than upper blades, due to increased pressure of water at increased depth below surface. Referring to Fig. 2, a right rotating propeller will thus cause deflection of stern to the right, causing the ship to turn left. This might be compared to torque and slipstream-offset effects on a plane. With

Fig. 2



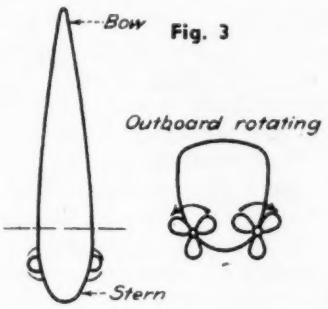

two screws the effect is doubled, requiring continual counteraction by rudder at high speeds. With the same ship in Fig. 2 in reverse speed, the contrary will happen—that is, the stern of the ship will be pushed to the left, while the ship will turn to the right.

This couple created by the screw is put to use by single-engine boats in harbors. With right rotation, a ship will turn easily to the right, almost on the spot, using successively forward speed, with right rudder, and reverse speed. In forward speed, the propeller backwash on the rudder beats the couple of the screw, leaving a resultant which pushes the stern to the left. In reverse, the screw turns left and its couple also pushes the stern to the left, turning the bow continually right.

The same ship turning left presents a different picture. Every gain in forward speed, this time with left rudder adding to the couple, will be offset by the couple in reverse, where the rudder is practically inactive, and much more space will be required.

Consider now a twin-engine ship, as sketched in Fig. 3. If it has outboard

Fig. 3




rotating screws, the right one turns right in forward speed and the left turns left, as seen from behind. Offset of the screw from the center line of ship causes a moment of rotation of the whole ship. Right engine forward pushes the bow left, the stern right. Right engine in reverse pulls bow right and the stern left.

It can be seen from this that in outboard rotation, the effects of propeller couple and offset are added both in forward and reverse speeds. With inboard rotation they will be subtracted. As the hull of a destroyer is long and narrow, inboard rotation had to be abandoned because this type was impossible to maneuver efficiently in harbors, although for speed it was superior.

### Effects on Single Engine Plane

In the case of rotation effect with single-engine aircraft, torque is first considered. This means that with right rotation of propeller, the plane itself tends to bank left, which must be compensated

(*Turn to page* 161)

• *No mere theorist, Mr. Hamelet has been a flyer since 1926, was a French Naval Aviation test pilot for four years, and left that service as a commander in 1940. First visiting this country as a member of the French Air Commission, he applied for citizenship after the armistice. At present he is working for Consolidated Vultee through special permission of the U. S. Navy.*

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### No other "blind" fastener has all these features

The Rivnut offers a combination of advantages which make it unique among blind fasteners. It is extremely simple in design—in fact, the only *one-piece* blind rivet that can also be used as a nut plate after installation. It is light in weight, low in cost, quick and easy to install. Because Rivnuts upset by bulging laterally, they expand to fill the hole in the skin and have a spring effect under load. Rivnuts may be inserted in a smaller hole in the skin due to their compact design. Threads are counterbored, thus making it easy to insert the screw. When upset, Rivnuts have a wider bearing area than any other blind fastener. They are made in three screw sizes and a complete range of grip lengths.

### Wide range of uses

Although developed primarily as a nut plate for the attachment of De-Icers, Rivnuts have found many other important uses in secondary and, in some cases, primary structure—in metal, plywood or plastics. These uses include: the attachment of landing and navigation light assemblies, instruments, fillets and fairings, Fowler flaps, insulation, and access doors for bullet sealing fuel cells.

### Can Rivnuts help you?

If you are engaged in aircraft manufacture or maintenance, chances are you can use Rivnuts to great advantage for applications of the type listed above, or for specialized applications of your own which require "blind" fastening. Why not tell us about any particular assembly problem you may have? We'll be glad to give you our recommendations. Aeronautical Division, The B. F. Goodrich Company, Akron, Ohio.

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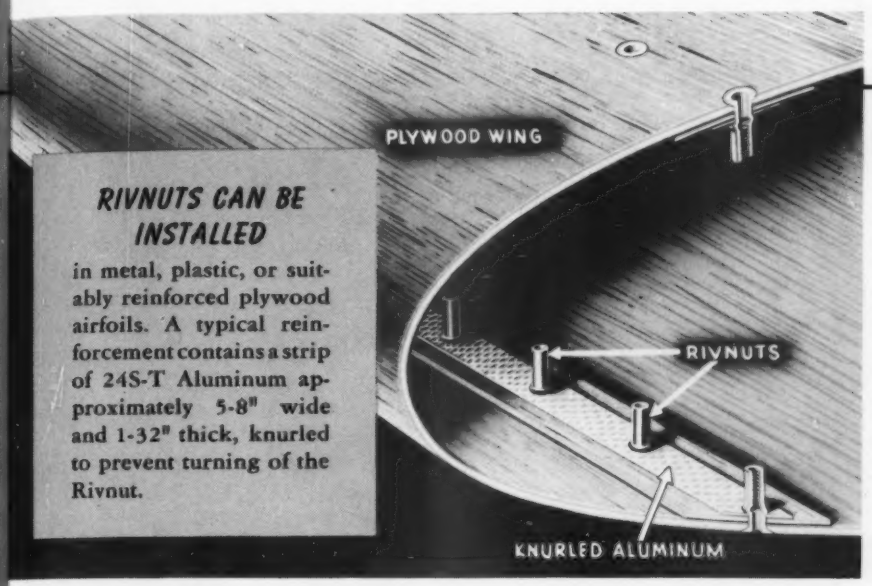
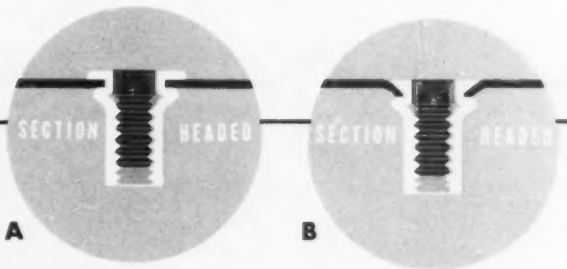
# RIVNUTS SAVE TIME AND MONEY

## Wherever blind fastening is needed!




***RIVNUTS CAN BE INSTALLED***

in metal, plastic, or suitably reinforced plywood airfoils. A typical reinforcement contains a strip of 24S-T Aluminum approximately 5-8" wide and 1-32" thick, knurled to prevent turning of the Rivnut.

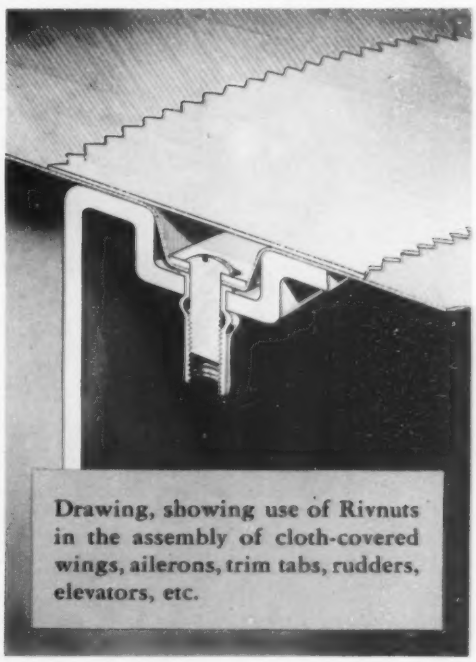



***CROSS-SECTIONS***

showing three types of Rivnut installations. (A) Flat Head type where absolutely flush surface isn't necessary; (B) Countersunk Head type with dimpled countersink in thin metal; (C) Countersunk Head Type with machined countersink in thicker metal.

***ATTACHING ACCESS DOORS***

like the one shown on the left is typical of the many uses for Rivnuts in aircraft assembly. Although originally developed as a nut plate for the attachment of De-Icers, Rivnuts now are being used in the attachment of navigation light assemblies, instruments, fillets and fairings, Fowler flaps, insulation, and many others.



Drawing, showing use of Rivnuts in the assembly of cloth-covered wings, ailerons, trim tabs, rudders, elevators, etc.

***RIVNUT INSTALLATION IS SO EASY***

even a blind man can do it. Right now, in one of the country's leading plants, blind men are heading Rivnuts on important aircraft assemblies and doing it mighty efficiently, too. Unskilled workers can learn Rivnut installation and become highly proficient in a very short time.

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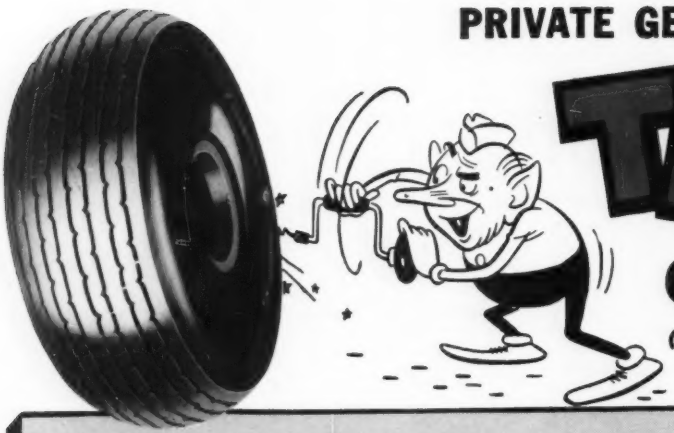
*In war or peace*

**B.F.Goodrich**

**FIRST IN RUBBER**

PRIVATE GEORGIE GREMLIN SCORED 0 ON THIS



# TIRE QUIZ

## CAN YOU SCORE 100%?

*(Pick correct answer from a, b, and c—see end for score)*

**1. The weather in Africa causes tires to deteriorate faster than the weather in Russia because . . .**

a. Bright sunlight has deteriorating effect on tires. More sunlight in Africa, therefore more deterioration.
b. Terrific sandstorms blast tires in Africa.
c. Desert heat melts tires.

**2. Private Jones got bawled out for spilling oil on a tire because . . .**

a. It made tire slippery.
b. Oil is extremely harmful to rubber.
c. There's an oil shortage.

**3. Tires should be examined regularly because . . .**

a. The Army is compiling tread-wear statistics.
b. If bruises and cuts are not discovered in time and repaired, tire may blow out and cause a crash.
c. Treads may be slipping.

**4. Tires should be repaired when cut to the cord because . . .**

a. Cords will rot; tube will be unprotected; tire may blow.
b. Air friction may set tire on fire.
c. Cords hold tire on rim.

**5. Overinflation should be guarded against because . . .**

a. The President is trying to curb inflation.
b. Overinflation causes rapid tread wear.
c. Overinflation increases tire weight.

**6. Underinflation is harmful because . . .**

a. It causes early failure of cord in the tire carcass.
b. It causes plane to bounce when landing.
c. It causes serious tube shrinkage.

**7. Valve cores should be checked regularly . . .**

a. Because leaks often develop at the valve core.
b. To see if they need lubrication.
c. To prevent valve tap.

**8. Valve caps should be on all valves because . . .**

a. They make a more streamlined appearance.
b. Caps keep dust, oil, and moisture out of valve; seal air in.
c. They are standard equipment on all Army planes.

**9. Deflection ribs are placed on smooth-contour tires to . . .**

a. Measure growth of tire in service.
b. Measure thickness of tread.
c. Show when a tire is properly inflated.

**10. Proper size tube should always be used because . . .**

a. Wrong size will either wrinkle and become pinched or stretch and lose air rapidly.
b. Too small a tube constricts the bead.
c. Too large a tube wastes vitally needed rubber.

**WHAT IS YOUR SCORE?**

Each correct answer counts 10. 1-a, 2-b, 3-b, 4-a, 5-b, 6-a, 7-a, 8-b, 9-c, 10-a.

This is one of a series of maintenance quizzes prepared for ground crew trainees of the U. S. Army Air Forces Technical Training Command. It is our hope that this series will help all maintenance men get maximum service, safety, and efficiency from military, commercial, and civilian aviation equipment.

**B. F. GOODRICH AERONAUTICAL DIVISION, AKRON, O.**

*Skyway or Highway*

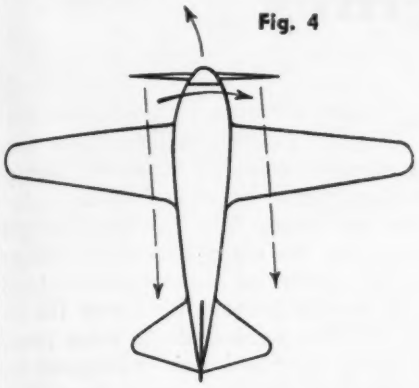
**B.F.Goodrich**

**FIRST IN RUBBER**

by left aileron trim. This increases drag and adds a slight tendency to turn left.

Another rotation effect is deviation of the slipstream, as sketched in Fig. 4.

Fig. 4



The air is definitely pushed sideways by the blades. Right rotation will give deviation to the right above the wing, to the left below it. Although this is less important than torque effect, it is not always negligible. Deviation above the wing usually preponderates because it has more chances of affecting the vertical tail surfaces, usually higher than the wing. This is especially true of flying boats. With the case in Fig. 4, the tail will be pushed to the right, contributing to left turn tendency.

Both these effects of torque and deviation are felt principally during initial period of takeoff, first because engines are at full speed, second because the controls have little action. Planes with powerful engines and large propellers, like the P-47 *Thunderbolt* and the English *Spitfire,* require some right-wheel brake, as well as right rudder, at the start.

The effects will also be felt more on flying boats than on land planes, because initial acceleration of a flying boat is smaller, due to hydrodynamic resistance of the hull. Also, on a seaplane, the increased pressure on the left pontoon (still with right rotation) will be much more important in its effects than pressure on the wheel of a landplane.

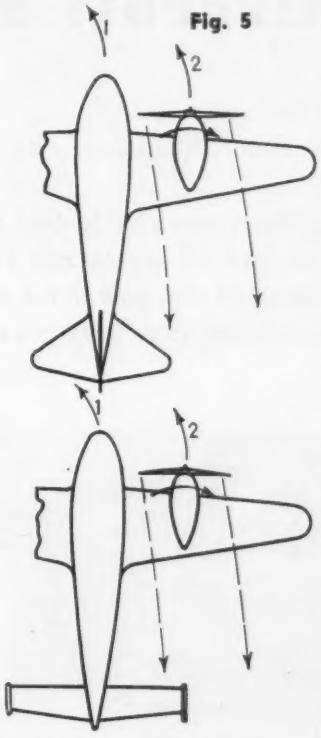
### Multi-Engine Planes

As with surface ships, a propeller mounted on the right or left of an airplane (this will be called offset) will create a moment of yaw or turn. By different direction of rotation, effects of offset and torque may be added or subtracted. Deviation must also be considered.

Referring to Fig. 5, let us consider a starboard propeller turning right or outboard. Torque effect is to the left; offset effect, evidently to the left. Deviation, on a single fin ship, will have no effect from this engine, but will exert a turning force to the left from a right rotating propeller on the left side. On a double fin ship the right engine as well as the left will cause a deviation effect, giving a third tendency to turn left.

A slight increase of speed will result if the slipstream does not meet the tail

Fig. 5




surfaces, since this air has greater relative speed than the normal air encountered. Chances of vibration and flutter will also be less, since the slipstream is turbulent.

### Outboard Opposite Rotation

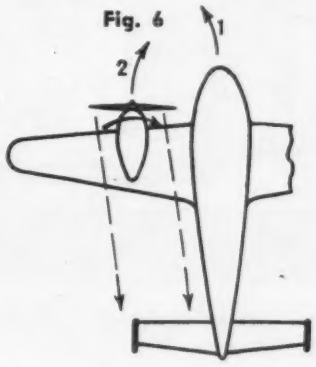
Here all effects balance each other. In the case of a twin-engine plane, it is fine as long as both engines are running, but with one engine stopped, poor performance will result.

For example, in a turn to the left with left engine stopped, everything pushes the plane into that turn. Tendency given by torque is to increase the bank, that of offset to increase rate of turn. Only a flat, cautious turn may be made to the left with left engine stopped. If we want to turn right with same left engine stopped, an excessive bank, or reduction of power, will have to be used, producing a loss of altitude.

### Inboard Opposite Rotation

Referring to Fig. 6, let us consider the port propeller, which turns right.

Fig. 6




Torque effect is to the left, offset effect is to the right, deviation effect to the left. The two most important considerations, torque and offset, are opposite and they more or less compensate each other.

In a turn to the right with right engine stopped, the tendency of left propeller torque is to decrease the bank, so stabilizing the turn. Compensating the offset, it also aids a left turn. The agreeable result, for the pilot, is to be sure of a good performance on one engine, with good maneuverability. You can turn on the side of the feathered propeller, even with a good amount of power on the remaining engine, without worrying about how that turn will end.

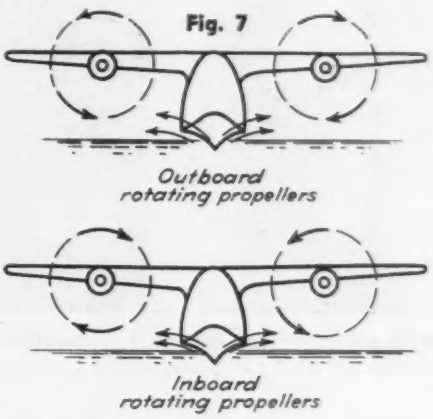
This fact appeared so important to aeronautical engineers of the French Air Department that all twin-engine planes built in France after 1938 had inboard rotating propellers.

### Specific Case of the Flying Boat

There is always some kind of extra complication when you come to flying boats. Here it arises from the fact that the propellers cannot be mounted high enough to keep absolutely clear of the water. During the takeoff—especially during the first part of the takeoff—a a lot of water and spray is projected on both sides of the hull by the bow.

If the propellers turn outboard (see Fig. 7) these projections will meet the

Fig. 7




lower blades with opposite velocities, with the risk of wearing or even bending them. Even if this does not ruin the propellers, there is great reduction of their efficiency during the early period of the takeoff. This bad effect will be aggravated when the boat is heavily loaded, and also when the sea is choppy.

With inboard rotating propellers, nothing of the sort happens. For the water projected by the bow is "pumped" by the propellers and projected outboard without extra stresses on the blades.

Although less important than the takeoff, taxiing on the water should also be considered: With inboard rotating

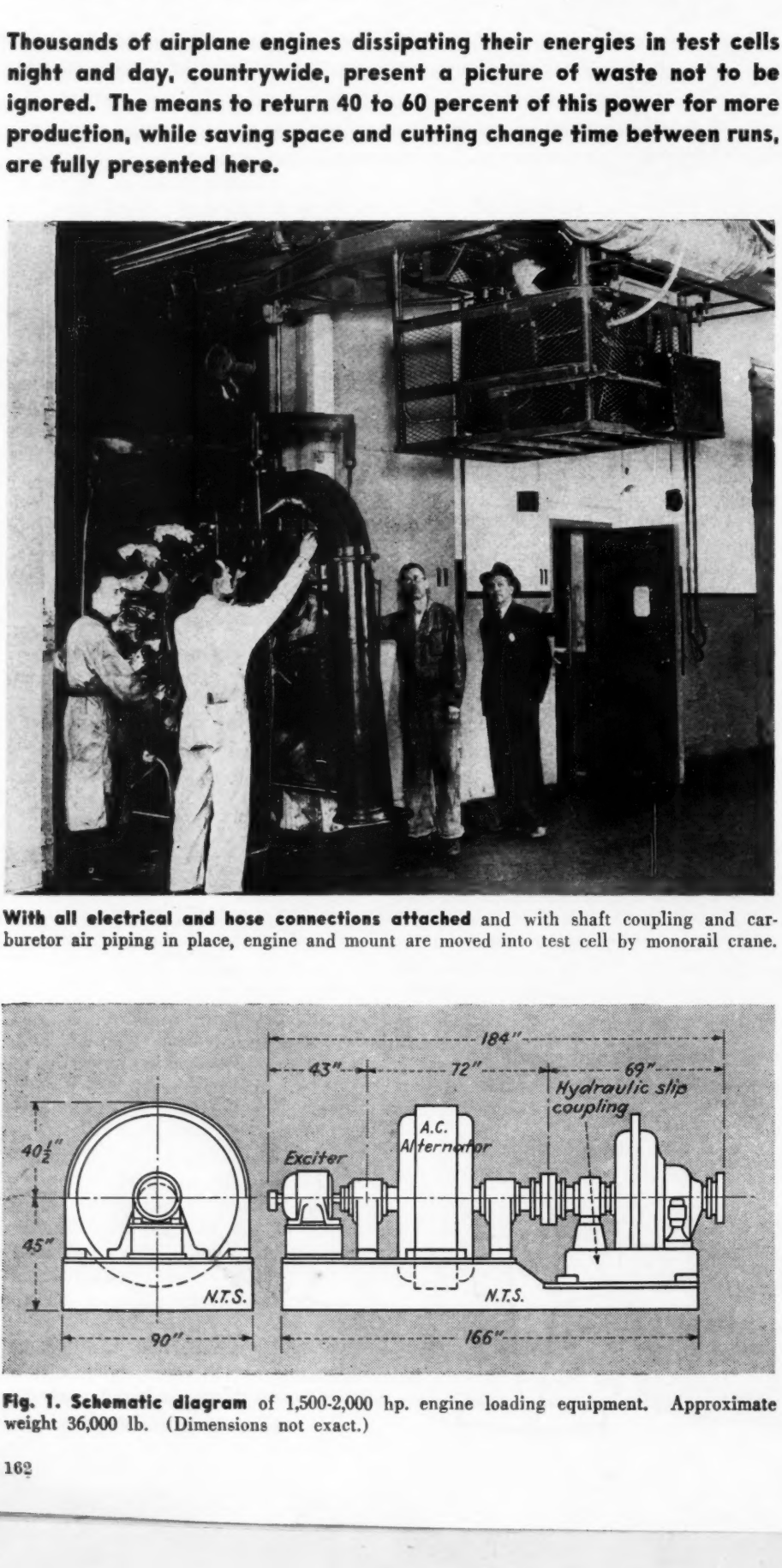
(*Turn to page* 393)

# Power Generation From Aircraft Engines

By R. L. FINDLEY

*Consulting and Application Engineer, Westinghouse Electric & Manufacturing Co.*

**Thousands of airplane engines dissipating their energies in test cells night and day, countrywide, present a picture of waste not to be ignored. The means to return 40 to 60 percent of this power for more production, while saving space and cutting change time between runs, are fully presented here.**



**With all electrical and hose connections attached** and with shaft coupling and carburetor air piping in place, engine and mount are moved into test cell by monorail crane.




**Fig. 1. Schematic diagram** of 1,500-2,000 hp. engine loading equipment. Approximate weight 36,000 lb. (Dimensions not exact.)

SEVERAL METHODS of production testing of aircraft engines have been developed in recent years to recover a large part of the power generated during test runs. This has been brought about by the rapid national expansion in the number of engines manufactured and by the increase in size of the engines. The engine plants using power recovery or "feed-back" equipment for loading the engines recover from 40 to 60 percent of the power required to manufacture more engines. They are approaching the old adage of "lifting themselves by their boot straps."

Testing of aircraft engines is unlike that of the automobile engine in that each engine is given a complete test of eight to twelve hours including tear down and inspection. These tests include engine loads up to and including that which would be developed during take-off of the plane. These are standard production tests. The minimum test for every engine is one such test. The exact testing schedule of horsepower loads, speeds, and time interval depends primarily upon the type of service of the engine. The loading torque during the test increases with speed. It will vary from a straight line increase to a squared increase, the latter corresponding to that of a constant pitch propeller.

Thus a very considerable amount of power may be recovered by some "feed-back" method using electrical machines for loading; or it may be wasted by propeller or brake testing. The usual method of loading in the past has been with either a constant pitch flight propeller or a stubby bladed propeller called a "club." Either of these were calibrated to determine the horsepower absorbed at the various speeds. This method had been considered as standard. However, the past three years has witnessed considerable interest and activity in loading with some type of electric brake and electrical "feed-back" equipment.

The consideration and application of other methods for loading the engine has primarily been brought about by four factors:

1. Increase in both the horsepower of the engine and in the number of engines being manufactured in one plant. Available power from tests is sufficient to be worth utilizing.

2. The fact that new engineering talent from the automotive industry is not influenced so strongly as to past practice.

3. Time saving in changing engines on a test stand. This increases production.

4. Saving in floor space, particularly for larger engines.

5. Savings in first cost investment per test cell equipment for the larger engines.

### Methods of Loading for Production Testing

Production testing may be divided into three general methods with equipment as indicated:

1. Propeller testing
   - (a) Constant pitch flight propeller
   - (b) Variable pitch flight propeller
   - (c) "Clubs"
2. Brake testing
   - (a) Water brakes with cradle parts, torque arm, and scale
   - (b) Electric brake consisting of eddy-current or inductor type generator with cradle parts, torque arm, and scale
3. Electrical "feed-back" testing
   - (a) Synchronous alternator, either single or two speed, with a slip-type coupling
   - (b) Wound rotor induction generator, either single or two speed, with secondary loading control
   - (c) Direct current generators with motor generator sets
   - (d) Squirrel cage induction generators, either single speed or multi-speed, with a slip coupling

### First Costs and Economies

The relative costs of these various systems involve so many factors as to size of engine tested, number of test stands, and location of test house that definite figures and recommendations cannot be made. In general, the lowest first cost of testing equipment for engines 250 hp. and less is the simple propeller method. This is particularly true provided the testing is made outside corporate limits. Sound proofing the engine test cell may be quite inexpensive.

For test houses of 250 to 750 hp. located inside corporate limits, where sound proofing against the propeller noise is required, the electric brake will, in general, be more economical. Outside corporate limits and with a minimum amount of sound proofing, the propeller method may still be the more economical. The electric brake is water cooled. The cost of cooling water may further effect the economies of the two methods.

The testing equipment with lower first cost for 1000 to 1500 hp. will usually be found as the water cooled electric brake. Even with relatively expensive cooling water, a cooling tower and water circulating equipment may be included in the cost differential between the test cell with electric brake, and the propeller house. The horsepower hours developed by an engine in the upper part of the 1000 to 1500 hp. bracket is sufficient to warrant investigation of power recovery or "feed-back" loading equipment.

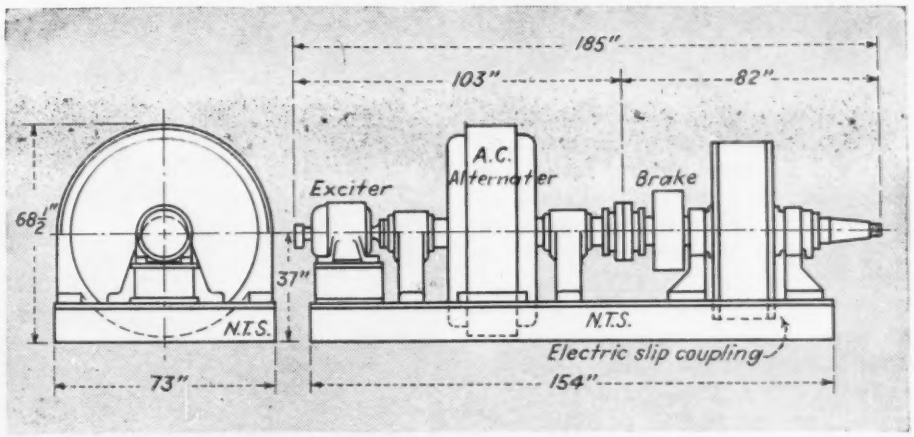



**Fig. 2. Schematic diagram** of 1,200-1,800 hp. engine loading equipment. Approximate weight 32,000 lb.

As a comparison, an average cost per test cell using a single speed alternator with a slip type coupling for testing 1200 to 1300 hp. aircooled engines is approximately $65,000. This figure is based on a test house with a minimum of 15 test stands using common oil, gas, and carburetor air service for the engines, individual exhaust and supply fans per cell, a common generator and control room, individual engine cells, and a double operator's room. The same general arrangement using a water cooled electric brake is approximately $12,000 less per test cell.

Power recovery from the "feed-back" equipment based on 1½ engines per day and valued at ½c. per kwh., is approximately $5,000 a year per cell. The power recovered pays the difference in first cost of the test cell in 2½ years. The sound proof propeller house with approximate cost of $58,000 is balanced with the recovered power in 1½ years.

The picture of first costs for testing equipment changes somewhat for the higher output engines. First cost of power recovery equipment versus propeller testing is about the same for a 2000-hp. engine. Above the 2000 hp. rating, the power recovery equipment, in general, will have a lower first cost per cell. Again this is based on a test house with 15 or more test stands. As a comparison of the two methods of testing, the average cost per test cell for an

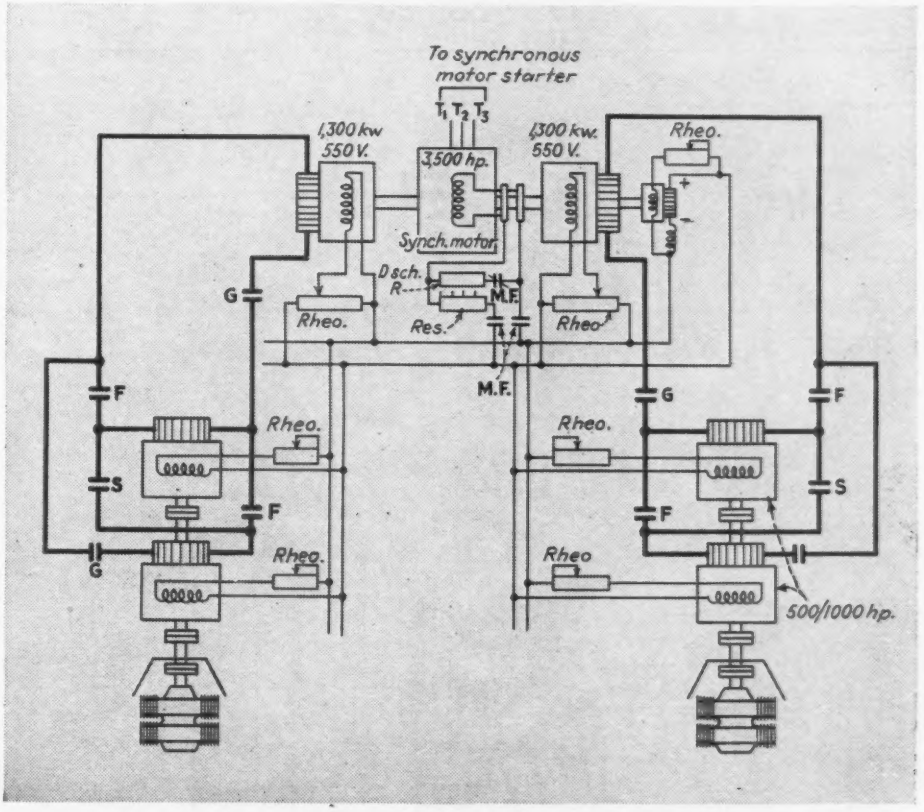
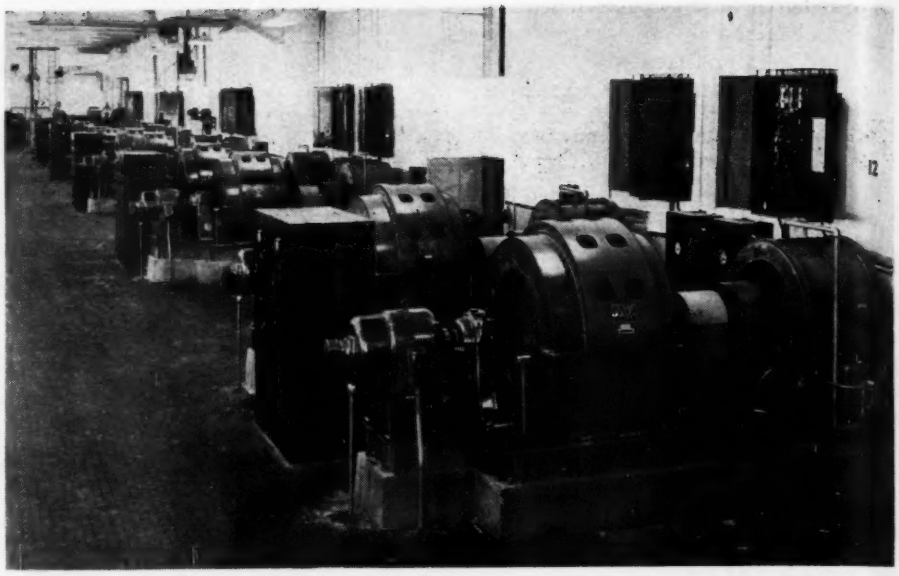



**Fig. 3. Diagram of direct current loading** on 1,500-2,000 hp. engines. Loading generator 500-1,000 hp., 800-1,600 rpm. Series parallel operation. All ratings are absorbed.

aircooled engine above 2000 hp. using a wound rotor induction generator is approximately $95,000 per test cell complete as compared to $110,000 per test cell for propeller testing. The value of the power recovered further favors the power recovery equipment. Valued at ½c. per kwh., 1½ engines per day and a 300 day year, the recovered power is $11,000 per test cell.

The floor space required per test cell for power recovery equipment of the higher horsepower test stands is considerably less than that for a propeller house. This comparison is further exaggerated if space requirements are figured on the basis of the number of square feet floor space to test a given number of engines in one day. On this basis, the floor space for propeller testing is approximately double that for power recovery equipment. This is due both to more floor space per cell and also the longer time required in mounting and "readying" an engine for test. An average time of change for an aircooled engine tested on an alternator with slip coupling is 30 min. total elapsed time from the moment the ignition is "cut" on one engine until the following engine is ready to fire.

This compares very closely to an average of 40 min. for a liquid cooled engine loaded on an electric brake. The corresponding average time interval for changing engines in a propeller test cell with the engine mounted on a steel cylinder several feet from the floor is approximately 2½ hr.



**Synchronous generator of 1,250 kva. and 900 rpm.,** with magnetic slip coupling for testing 1,200-1,800 hp. engines.

**TABLE I**

| Engine b.hp. | Engine Prop. Shaft rpm. | Absorbed Alternator Rating | Alternator Speeds | Cost of Equipment | Kwh. Recovered Per Engine |
|---|---|---|---|---|---|
| 400 | 2,400 | 150/300 hp. | 900/1,800 | $8,600 | 760 |
| 400 | 2,400 | 300 hp. | 1,800 | 7,200 | 720 |
| 1,400 | 1,260 | 450/1,000 kva. | 450/900 | $23,500 | 2,600 |
| 1,400 | 1,260 | 1,000 kva. | 900 | 22,000 | 2,500 |

**TABLE II**

| Engine b.hp. at Take-Off | Engine Prop. Shaft rpm. | Alternator Synchronous rpm. | Total kwh. Delivered By Engine | Kwh. Feed-Back | Ratio kwh. Feed-Back |
|---|---|---|---|---|---|
| 400 | 2,400 | 1,200 | 1,657 | 889 | 54% |
| 400 | 2,400 | 1,800 | 1,657 | 1,157 | 70% |
| 1,200 | 1,510 | 720 | 5,925 | 3,440 | 58% |
| 1,200 | 1,510 | 900 | 5,925 | 3,840 | 65% |
| 2,000 | 1,400 | 720 | 9,370 | 5,806 | 62% |
| 2,000 | 1,400 | 900 | 9,370 | 6,397 | 68% |

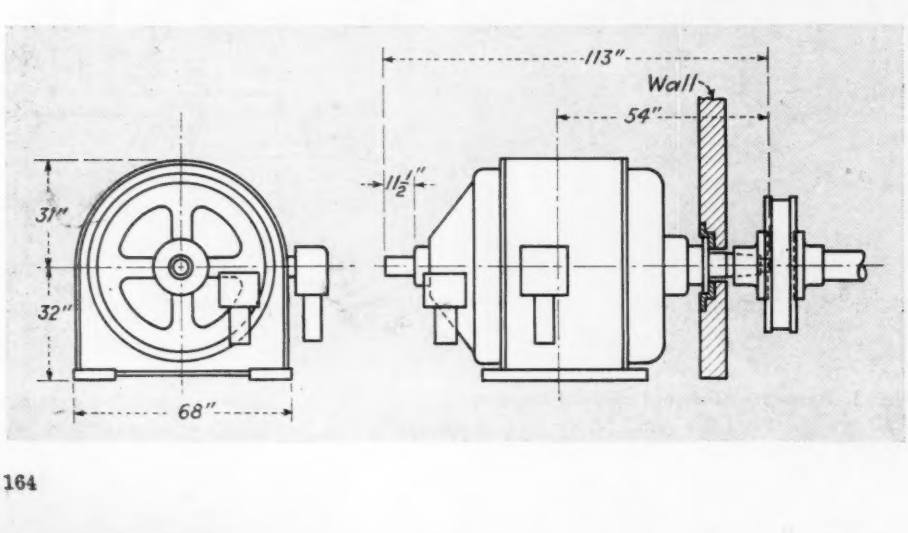



**Fig. 4.** Wound rotor induction generator loading 2,000-2,500 hp. engines. Approximate weight 18,000 lb.

### Alternator Testing with Slip Type Coupling

Production testing (note Figs. 1 and 2) using a synchronous alternator requires some type of slip coupling to permit the alternator to operate at its synchronous speed and the engine speed to be varied over the required testing schedule. The coupling may be either the electric or hydraulic type. The electric type may be aircooled or water cooled. Since the aircooled type is considerably larger and, therefore, more expensive, it is not commonly used. The hydraulic type is cooled by circulating its oil through a water cooled heat exchanger. The alternator is started as a standard synchronous motor by connecting it across the a. c. power system.

In event the starting kva. is excessive for capacity of the power system, it is started first at reduced voltage and then transferred to full voltage. During this starting operation the field of the electric coupling is opened or the oil of the hydraulic coupling is removed. The engine crank shaft thus remains stationary during this starting period. The engine is cranked and brought to its firing speed by increasing the field strength of the electrical coupling or increasing the oil level in the hydraulic coupling.

The engine is loaded on the alternator when its propeller shaft is operating above the synchronous speed of the alternator. In event loading is desired below this speed, the alternator is disconnected from the power system and the output shaft of the coupling is locked by a holding brake. Entire engine load is absorbed by the coupling. Field

strength of the electric coupling or oil level of the hydraulic coupling determines the engine load. Capacity of the coupling limits engine loads at these reduced speeds. At propeller shaft speeds above the alternator synchronous speed, engine load and speed are regulated by the throttle setting and field strength of the electric coupling or oil level in the hydraulic coupling. The power of the engine is absorbed both by slip coupling and alternator.

The horsepower absorbed by the slip coupling is—

$$\text{Hp. to coupling} = \frac{\text{Engine b. hp. (Engine rpm.—Generator rpm.)}}{\text{Engine rpm.}}$$

The engine rpm is the speed of the propeller shaft.

$$\text{Hp. to the alternator} = \frac{\text{Engine b. hp.} \times \text{Generator rpm.}}{\text{Engine rpm.}}$$

The horsepower delivered to the generator, minus generator losses, is the power delivered back to the plant system to manufacture more engines.

From the above formula, the necessity of picking the correct generator speed is apparent. Speed of the generator must be such as not to overload the coupling or waste too much power during the testing below generator synchronous speed. Also, since the larger part of available power occurs near top speed of the engine, the generator speed should be kept as high as possible. This gives minimum loss in the coupling and maximum power delivered back to the factory distribution system.

For testing schedules where engine torque increases as the square of the speed, or very nearly so, the correct speed of the generator is approximately 70 to 75 percent of rated engine propeller shaft rpm. This will be affected somewhat as to the relative lengths of tests at lower speeds and higher speeds. With unusual emphasis on tests at 90 percent speed and above, ratio of generator speed may be 80 percent. Before making a final selection of generator speed, power recovery for two or three speeds should be made using proposed test schedule. Generator kw. capacity per rpm. is essentially constant near these speeds. This indicates cost of electrical equipment is not greatly affected.

Some advantages will be gained by using a two speed alternator. A smaller and less expensive coupling may be employed and a greater percentage of the engine power will be recovered. However, cost of the alternator and its control will be increased, offsetting these advantages. Two comparisons are shown in Table I.

Several schemes may be used for loading the engine below synchronous speed of the alternator, including—

1. Locking output shaft of slip coup-

(*Turn to page* 351)

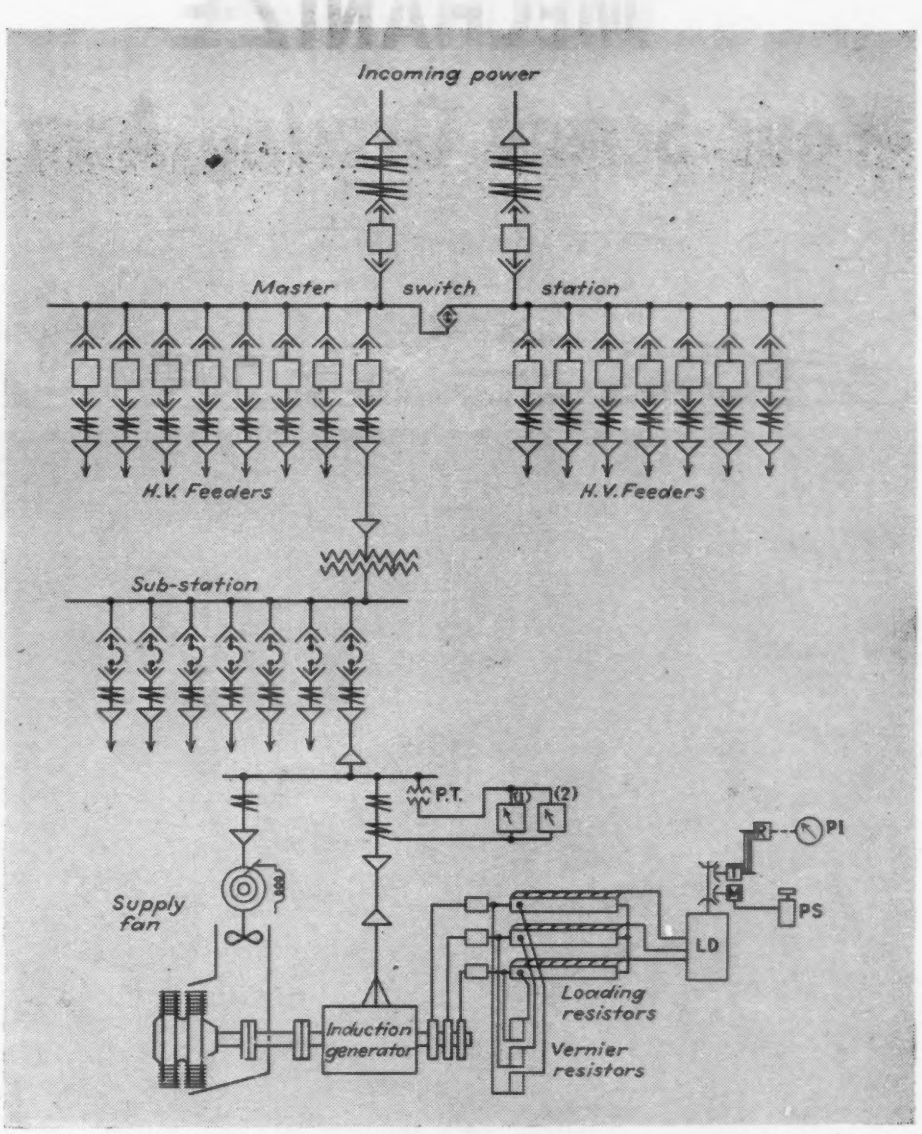
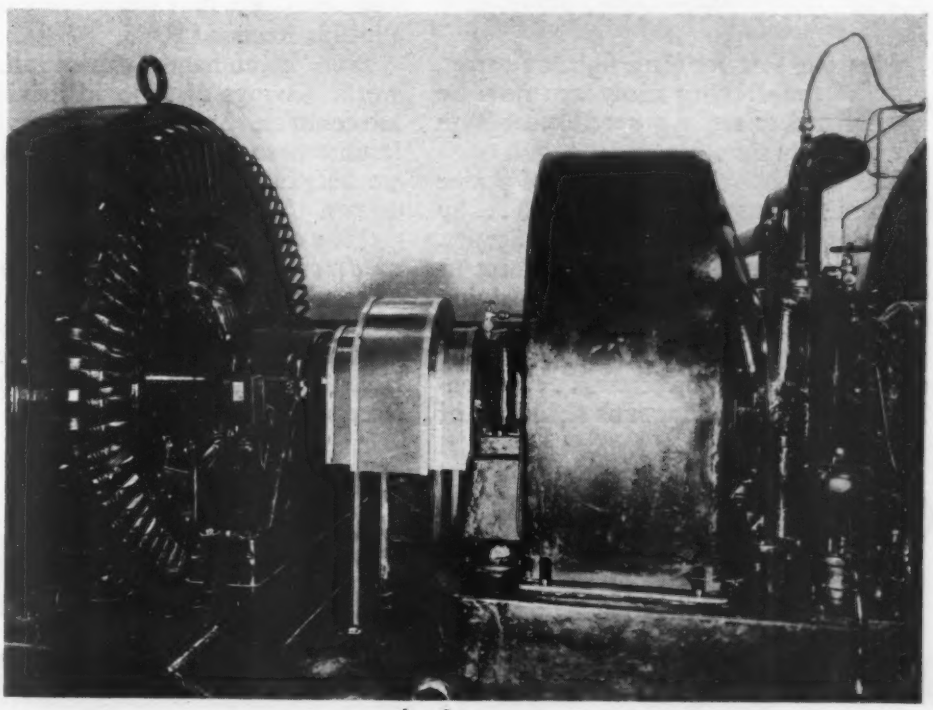
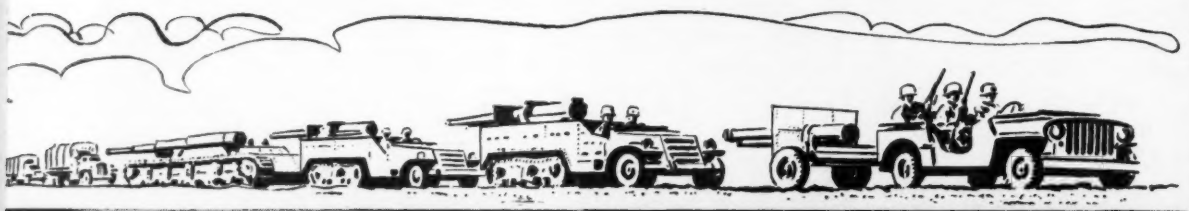



**Fig. 5. Induction generator loading.** Key: (1) kwh. meter; (2) torque meter; (R) receiver; (T) transmitter; (LD) loading drum; (M) drum motor; (PS) position selector; and (PI) position indicator.



**Alternator of 1,250 kva. and 720 rpm.,** with hydraulic slip coupling used for testing 1,500-1,800 hp. engines.

# MECHANIZE
# Your Screw Driving Army



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Like our fast-moving fighting forces, your screw driving army can now be mechanized to set new speed records on the assembly line.

You can have the advantages of power or spiral driving on almost any job . . . by adopting Phillips Recessed Head Screws. Automatic centering of driving force in the Phillips Recess eliminates the driving troubles that often make fast driving methods impractical. Fumbling, wobbly starts . . . slant-driven screws . . . broken-head screws . . . dangerous skidding of driver points . . . all are forgotten problems in plants that use screws with the Phillips Recessed Head.

Even "green hands" can do fast, skilled work. Savings of 50% in driving time are common. Such man-hour savings are important to the war effort, since so many workers in the average plant are driving screws.

*They cost less to use!* Compare the cost of *driving* Phillips and slotted head screws. You'll find that the price of screws is a minor item in your total fastening expense . . . that it actually costs *less* to have the many advantages of the Phillips Recess in your assembly work.

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The Phillips Recessed Head was scientifically engineered to afford:

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**Faster Driving** – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

**Easier Driving** – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

**Better Fastenings** – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

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The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

# Hydraulic Efficiency of Rubber Pads

By WARREN TUCKER

*Director of Research Department, Hydraulic Press Manufacturing Co.*

**How fluid is rubber? For accurate calculation of stresses in rubber forming operations, this question requires an answer — and it is given here in results of systematic tests made by an authority in the field.**

USE of the Guerin process, comprising employment of a rubber pad and a simple inexpensive die to form sheet metal parts, is becoming more and more prevalent. Being based on the principal of transmitting pressure equally in all directions by means of a fluid medium, using rubber as this medium, it is very desirable to know just how fluid rubber is.

We know that when restrained and put under pressure, it will form sheet metal over complicated die shapes using a flat press head. In cutting or blanking operations, it induces tensile stresses, which are concentrated at the desired places by the cutting block, and the metal is fractured or cut when these stresses exceed the metal's ultimate strength.

The tests detailed here are to establish the degree of fluidity of rubber, so that these cutting and bending forces can be exactly calculated.

The standard for static hydraulic fluid efficiency is a perfect hydraulic fluid, which is a substance such that pressure exerted by it on any surface is everywhere normal to that surface. From this it follows that any friction between solid and fluid is impossible, since this would necessitate action of force tangential to the surface. It also follows that there can be no frictional resistance to motion of the solid body through the fluid, or to the steady motion of the fluid through any pipe or channel having solid boundaries.

Therefore, any portion of the fluid may be separated from any other portion by a force however small, if applied for a sufficient length of time. Furthermore, a perfect fluid is incapable of existing in a state of tension.

No such substance as a "perfect" fluid is known in nature. All fluids, through their properties of cohesion and viscosity, offer some resistance to motion of any solid surface with which they may be in contact. When dealing with water, impregnated as it usually is with air in solution, the effect of cohesion may be neglected, and when at rest water may be considered as satisfying the essential condition of a perfect fluid in that it exerts a pressure normal to all surfaces with which it may be in contact.

This means that in an application where the fluid is held in a container similar to that depicted here in Fig. 2, and a force $P$ is applied to the plunger, the resisting force $P_1$ in the trapped fluid is equal to $P_2=P_3=P_4$, and the force has been transmitted equally in all directions.

In the application under consideration, rubber has been used as the hydraulic fluid, and these were made to determine the side pressure to the container marked as $P_2$ and $P_4$ in Fig. 2. This has been expressed as static hydraulic efficiency of rubber and is presented by the following equation:

$$\text{Static fluid efficiency} = \frac{\text{Pressure per sq. in. applied to pad} \times 100}{\text{Pressure per sq. in. transmitted}}$$

Due to the fact that rubber is not a

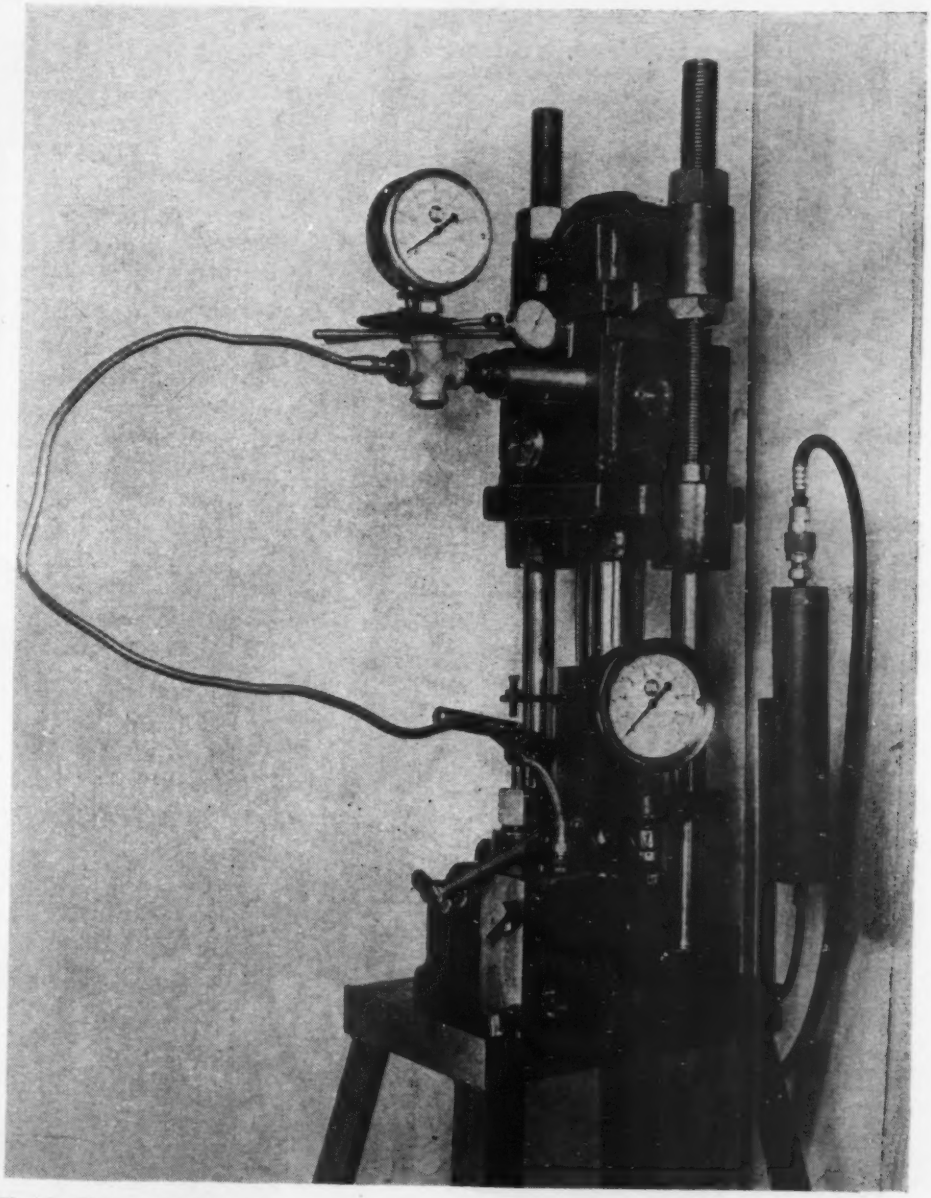

**Fig. 1. Press employed in tests** was this 10-ton unit made by Hydraulic Press Mfg. Co.

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perfect fluid, wall friction will have some effect on the results. Readings were taken at the locations shown in Fig. 3 to determine the amount and effect of this friction. In actual practice the five points were on different sides of the box to facilitate testing.

Equipment used in the experiment, shown in Fig. 1, consisted of a ten-ton HPM laboratory press, two rubber pads of 50-60 Durometer supplied by the B. F. Goodrich Co., pad holder, pressure gages, dial indicator, and an auxiliary hand pump. Pressure was transmitted to the rubber by a punger $4\frac{13}{16}$ x$4\frac{13}{16}$ in. The set-up is shown diagrammatically in Fig. 4.

Procedure was as follows: When the face of the plunger was exactly flush with the inside top of the chamber wall, the dial indicator (so marked in Fig. 4) was set at 0. Pressure was then built up in the main ram, which forced the plunger into the chamber. The next step was to build up pressure in the auxiliary cylinder, until the dial indicator was again brought to O. The difference between main and auxiliary cylinder pressure readings gave the measure of static hydraulic efficiency of the rubber pad.

This process was repeated at the various locations shown in Fig. 3, indi-

(*Turn to page* 360)

**TEST ON RUBBER PAD 50-60 DUROMETER**

*Average hydraulic efficiency of rubber, 90.5 percent.*

| Tonnages Applied to Pad | Pressure per square inch applied to pad | Pressure per square inch in position A* | Pressure per square inch in position B* | Pressure per square inch in position C* | Pressure per square inch in position D* | Pressure per square inch in position E* | Average | Hydraulic Efficiency of Rubber % |
|---|---|---|---|---|---|---|---|---|
| 2 | 173 | 169 | 156 | 150 | 160 | 160 | 159 | 92 |
| 3 | 259 | 245 | 225 | 229 | 250 | 248 | 239 | 92.3 |
| 4 | 345 | 323 | 305 | 315 | 326 | 326 | 319 | 92.5 |
| 5 | 432 | 395 | 367 | 363 | 377 | 375 | 375 | 87 |
| 6 | 518 | 477 | 462 | 460 | 472 | 472 | 468 | 90.5 |
| 7 | 604 | 550 | 553 | 550 | 555 | 555 | 553 | 91.5 |
| 8 | 691 | 649 | 618 | 612 | 613 | 629 | 624 | 90.5 |
| 9 | 777 | 702 | 709 | 700 | 709 | 700 | 704 | 90.5 |
| 10 | 863 | 806 | 766 | 757 | 755 | 769 | 771 | 89.7 |
| 11 | 950 | 868 | 845 | 845 | 852 | 853 | 853 | 90 |
| 12 | 1036 | 950 | 927 | 938 | 950 | 942 | 941 | 90 |
| 13 | 1122 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 89 |
| 14 | 1209 | 1100 | 1100 | 1100 | 1050 | 1100 | 1090 | 91 |
| 15 | 1295 | 1175 | 1175 | 1175 | 1175 | 1175 | 1175 | 90.5 |

*Each value given is the average of five readings.

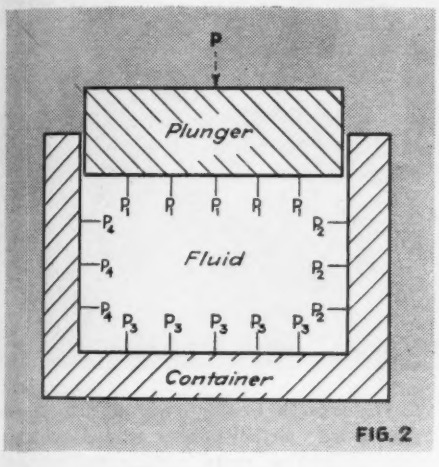


FIG. 2

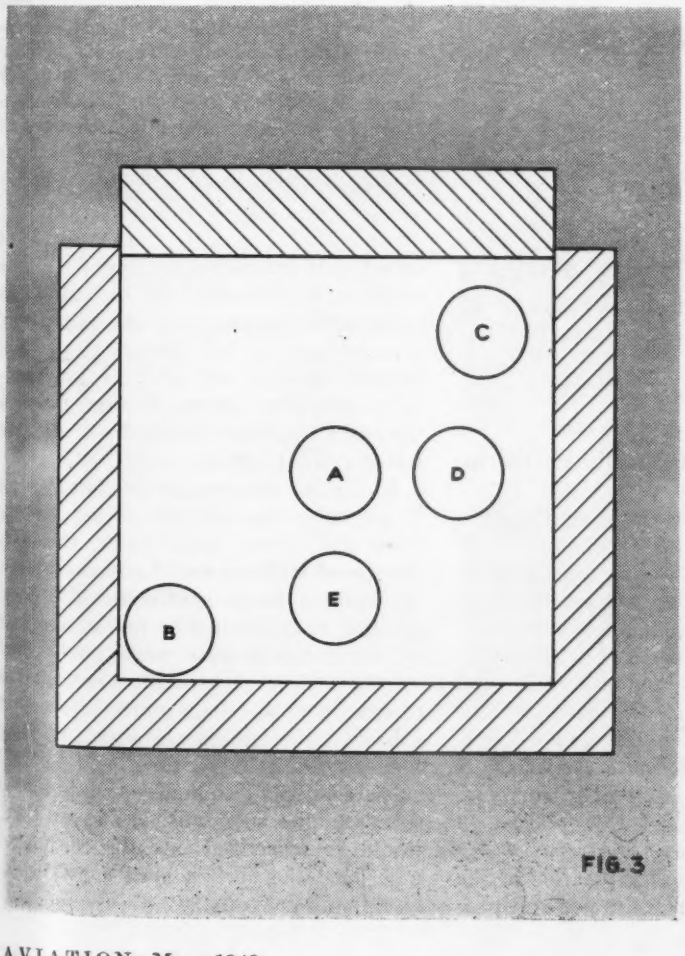


FIG. 3

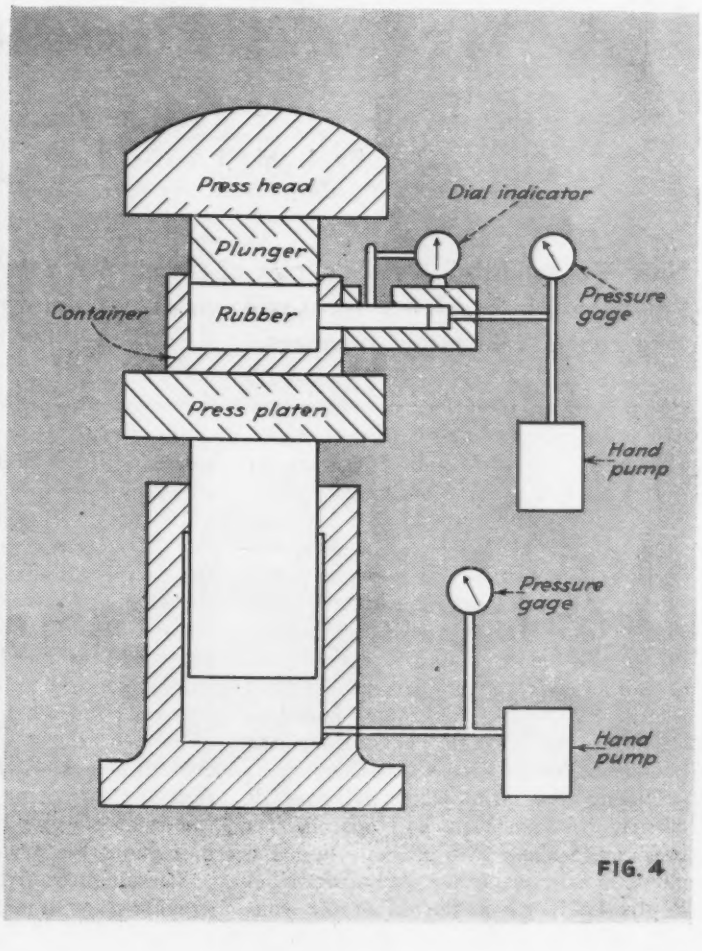


FIG. 4

**Swift growth** from pre-war to present day production methods necessitated elimination of central parts storage system—adequate warehouse facilities simply didn't exist—and brought savings in man-hours. Fabrication of subassemblies was timed to reach proper place at right time, at same rate complete planes were moving off final assembly line. Above, B-24 *Liberator* bomber fuselage tail sections emerge from fixtures in background, get finishing touches enroute to final assembly in foreground.

# Reduction of Man-Hours In Aircraft Production

**By I. M. LADDON**
*Executive Vice-President, Consolidated Vultee Aircraft Corp.*

**How Consolidated Vultee's rule-of-thumb for fabricating efficiency has grown into science for saving priceless time in manufacture of long range "Liberator" bombers.**

ONE of the outstanding factors in America's swiftly growing aircraft production to meet the United Nations' wartime demands has been the sharp reduction in man-hours per plane fabricated. Among the greatest such time slashes are those which have been accomplished at the two San Diego plants of Consolidated Vultee Aircraft Corp., where the B-24 *Liberator* bombers, PBY-5 *Catalina* and PB2Y *Coronado* patrol bombers are fabricated.

During the past year, the over-all efficiency increase in both plants has been more than 200 percent, and the curve is still rising. Calculating from Sept., 1941, when the *Liberator* conveyor line was first established, the increase is even greater.

Despite a tremendous labor turnover due to selective service demands, plus the complication of hiring and training thousands of unskilled women, the company today is producing 2.5 planes for every one produced in Apr. 1942, while employment of production workers has increased but 10 percent. Employment of women has risen from less than 1 percent in Dec. 1941, to more than 43 percent at this writing, a great majority of the women being hired to replace men going into the armed forces.

These figures give an indication of the great savings in man-hours per unit produced, but in discussing specific reductions on the *Liberator,* for example, it is essential to have a basis of comparison. This basis may well be the production methods used to fill what we now consider comparatively small orders prior to the vast pre-war production increase which started rolling in 1939-40.

Under the pre-war production system, if an order for say 60 planes (a big order in those days) was received, groups of workers would concentrate on the various parts needed for the components and produce 60 units. As fast as these components were made they were stored in a central stockroom, there to remain until all the parts for certain subassemblies had been completed. They then would be withdrawn and the 60 subassemblies fabricated. And as the 60 subassemblies were finished they, in turn, would be assembled into the completed unit until the 60 had been constructed, tested, and delivered.

**With central finished stockroom** eliminated, Consolidated pioneered with installation of smaller stock bins along all subassembly and assembly lines. This not only saved many man-hours required to move stock in and out of old type storeroom, but also made it possible to avoid tying up large quantities of raw and fabricated materials.

**Consolidated *Liberator* bombers** move down final assembly line at 45-deg. angle, literally making line 50 percent longer, since 33 1/3 more stations can be put on it and still give room for all operations with ample space for time-saving stock bins.

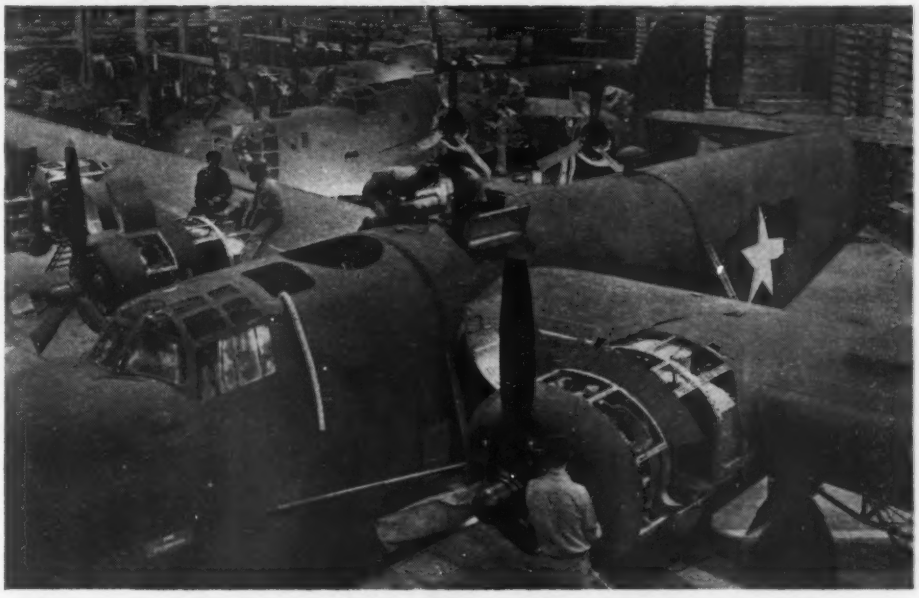
This system was economical in filling small orders, as it saved set-up time and parts fabrication cost. Once a job was started, the 60 units were completed in sequence; if ten units per ship were needed, then 600 would be produced.

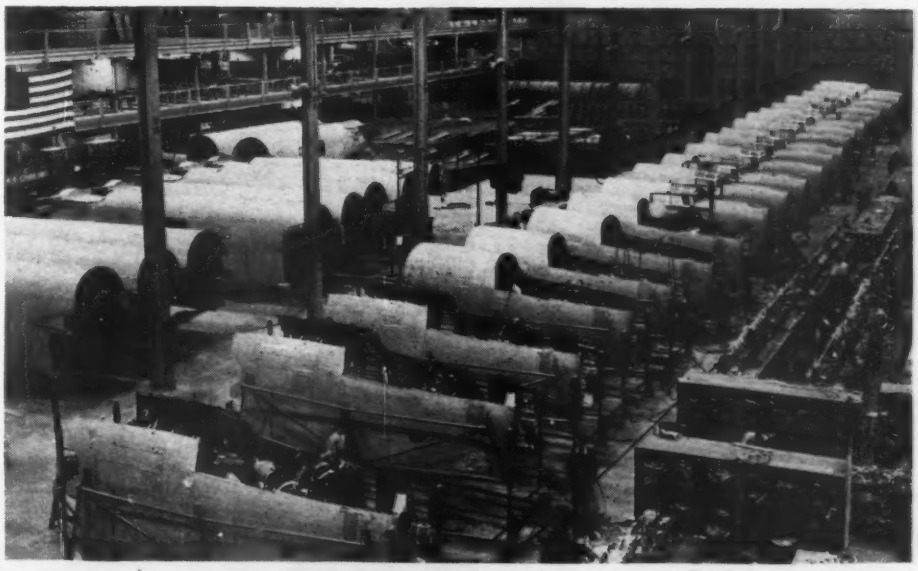
Under this method there can be set forth a thumb rule for increased production efficiency, which is in reality the lowering of man-hours on each unit or group of units. This rule is based n the learning curve which, in turn, is based on the simple fact that the more times a human being, or group of human beings, does a job, the better they do it individually and together.

The thumb rule is that when a manufacturer doubled the number of units produced, he reduced man-hours for the entire quantity by 20 percent. To apply this mathematically, let us say that for the first 100 units of airplanes produced, the man-hours involved in each amounted to 100,000. With the manufacture of the next 100 units of the same aircraft, the man-hours for the full 200 units should drop to 80,000 hr., which means that the second 100 units were produced at a cost of 60,000 man-hours.

With 400 units completed it is found that the entire 400 were produced at a cost of 64,000 man-hours per unit, with the last 200 costing but 48,000 man-hours per unit. Carrying the thumb rule on to 800 units, the over-all average per unit drops to 51,200 man-hours, with the units from 400 to 800 costing only 38,400 man-hours per unit. From 800 to 1,600 units, the over-all cost per unit drops to 40,960 man-hours for the 1,600 units produced. Units from 800 to 1,600—the last 800 produced—cost but 30,750 man-hours per unit.

Application of this thumb rule to the manufacture of *Liberators* shows that Consolidated has beaten "par" by about





**Fuselage nose installation** originally required 6,000 man-hours, and not more than six employees could work effectively inside at once. Opening section along four cleavage lines enabled more workers to operate at same time, not only speeding output but resulting in over-all reduction of man-hours necessary. New tooling to further simplify this process is under way.

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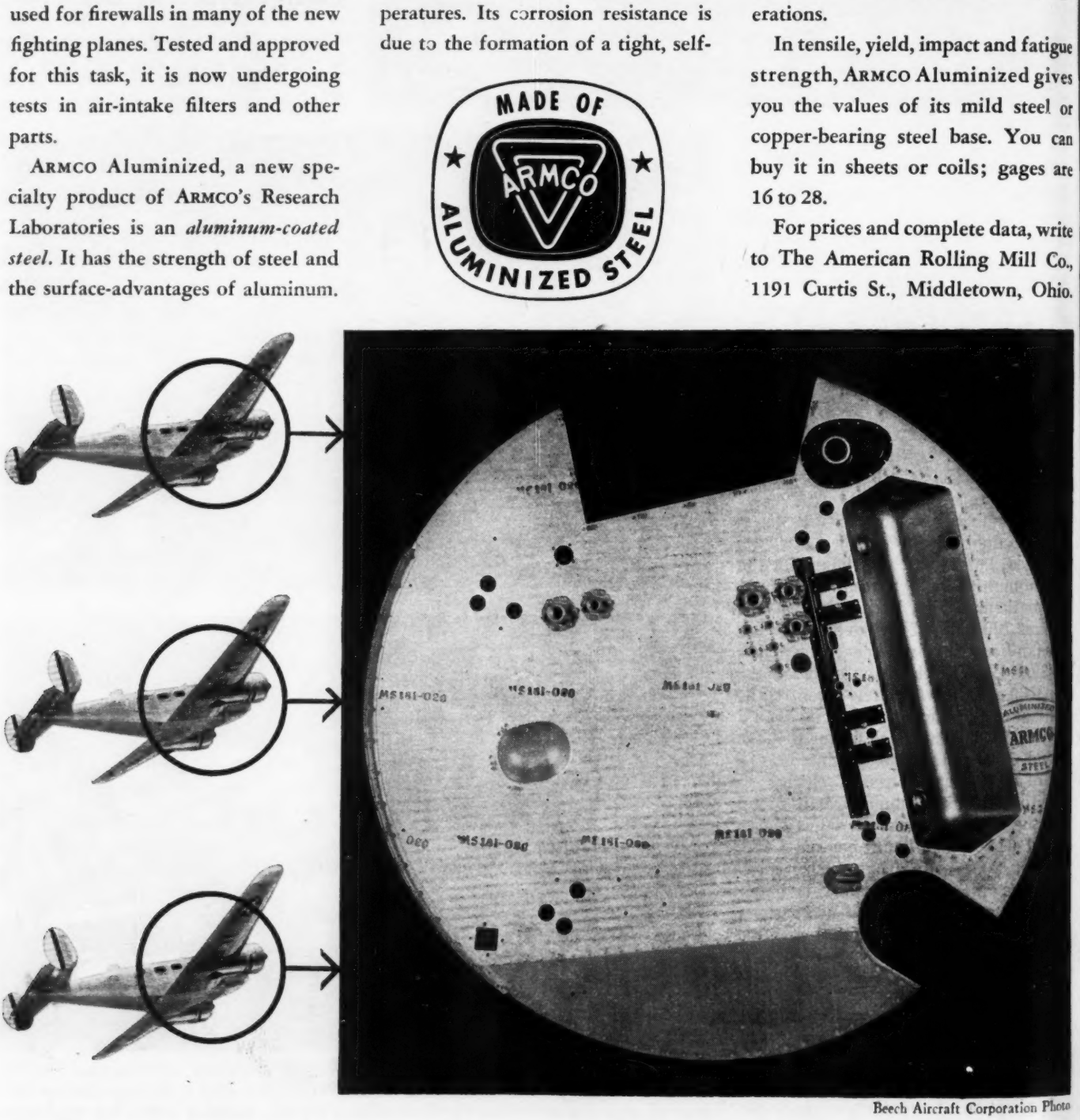

Beech Aircraft Corporation Photo

## THE AMERICAN ROLLING MILL COMPANY

50 percent. Improved manufacturing methods have given the company the difference between par and the production "eagles" which have been scored.

What, then, are some of the methods which have made possible this progress in reducing man-hours? Let us consider this question:

With the inception of today's large orders, which have brought huge and originally unanticipated expansions, several problems arise if attempts are made to adhere to the old methods. For instance, plant stockrooms would be hopelessly inadequate to hold the millions of finished parts. At the start of *Liberator* production, all available warehouse facilities in San Diego were leased. Had the old methods been retained these facilities would not only have been filled but would have overflowed to hamper production. Even under present construction practices, new warehouses are constantly being built.

This parts storage problem brought about the necessity for establishment of a flow of raw materials through fabrication processes into subassembly lines and also the flow of subassemblies into the final assembly line. At each point in the process of manufacture, the right number of fabricated parts must reach the right place at the right time, and the entire flow must be in a direct line to the last operation before testing the completed aircraft.

The first step was to get each fabricating and subassembly department in the plants scheduled to produce parts and components at the same rate that the aircraft were coming off the final assembly line. This resulted in abolishing the central finished parts stockroom and installation of stock bins along all subassembly and assembly lines. It was found that this made a large cut in the number of man-hours required to move stock in and out of the old type central stockroom. Not only was there a definite saving in the labor required to shift stock, but it was possible to avoid tying up raw and fabricated materials. In general, the small stock bins carry only an eight to ten days' supply.

This system of handling stock, pioneered by Consolidated Vultee, differs from other methods currently employed by many fabricators in the industry and is to some extent responsible for the company's success in cutting down man-hours on the *Liberator*.

When the assembly line first came under consideration, there arose the problem of whether the line should be moving or whether it should stand still. There were two obvious possibilities: To leave the airplanes in process of fabrication static and move the assembly crews from one plane to the next, or to move the airplanes and permit the crews to be stationed. Careful investigation resulted in a decision to mechanize all assembly lines. The flow of stock into the moving lines was obviously simpler than the flow of stock into a stationary line, due to the fact that stock, crews, and tools were pre-positioned at a planned work area. With a stationary line, these three elements had to move rather than the airplane.

This brings us to another cause for the

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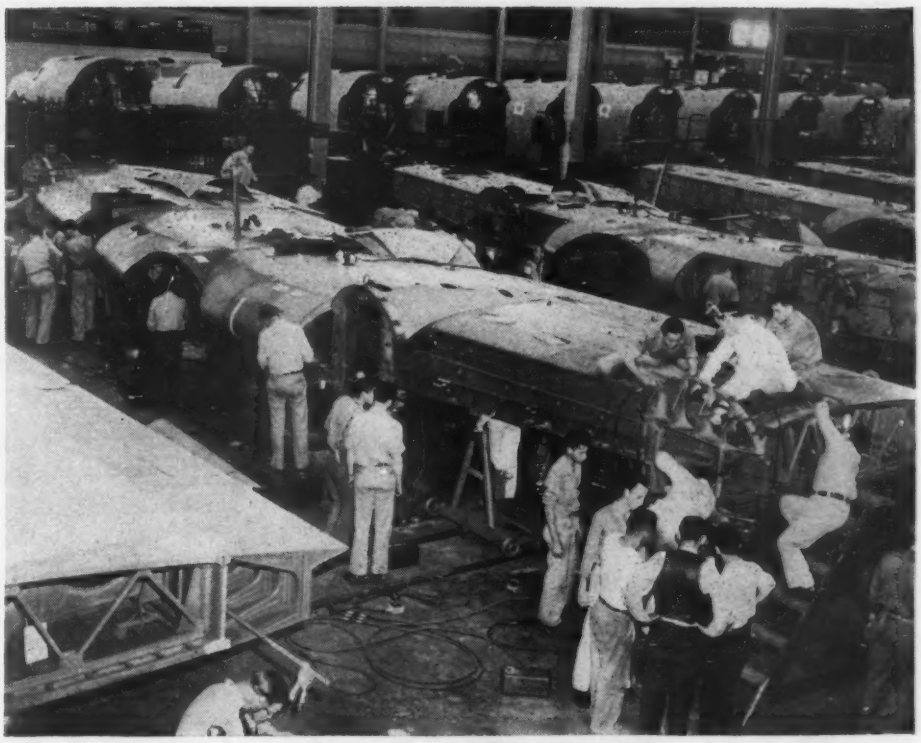
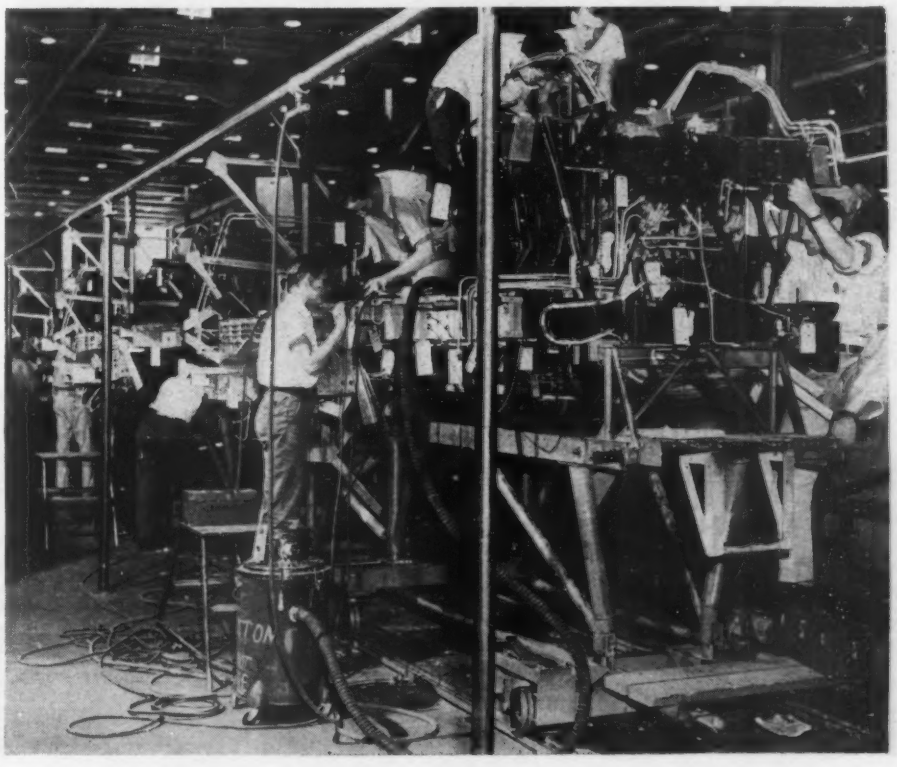


**Long, complicated assembly operations** are broken down into many subassemblies to save man-hours in *Liberator* production. Here, center wing sections, heart of the plane, move along mechanized assembly line where fabricating process has been broken into many comparatively simple operations.



**Large part** of Consolidated's 200-percent-plus efficiency increase within past year is attributed to greater tool design skill, better assembly, and special installation fixtures developed. Here, for example, is method employed to simplify and speed instrument installation.

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# Why Not Forged Engine Mounts?

By CHRIS FREY, *Chief Tool Designer, Brewster Aeronautical Corp.*

**Great strength, fast production, small shipping space, and easy assembly are some of advantages claimed for the forged mount. This designer offers pointed comparisons with the welded type.**

IF WE LOOK BACK on the history of aircraft construction, we note that at one time planes were made almost entirely of wood covered with doped fabric. Metal was used only where absolutely necessary. As more powerful engines were developed, enabling the plane to lift heavier loads, stronger fuselage frames were required. Welded tubular construction was the answer, and was accepted throughout the world wherever airplanes were made.

With the introduction of aluminum alloys into the field, construction was again revolutionized. Fuselage frames and wing ribs came to be pressed out of sheet stock and assembled with a stressed metal skin by riveting. It was still considered necessary, however, to continue making welded steel assemblies for such highly stressed members as engine mounts, landing gear, arresting hook, etc., as well as many small brackets that could not be fashioned satisfactorily from aluminum alloys. No revolutionary deviation from this practice was considered at that time because planes of all models were made only in small quantities, and mass production methods, as used in the automotive industry, would have been out of line.

Today, with large quantity production and standardization moving in, there is a trend to forgings in order to eliminate small steel assemblies. Many hundreds of skilled man-hours are saved by this practice. And through the use of proper tooling, parts can be easily machined to insure interchangeability.

Engine mounts are one of the items which have not been seriously considered in the conversion program, unless we mention the forged engine mounts on German Messerschmitts. When we compare the forged mount with the welded type, there appears considerable difference of advantage in methods of manufacture. Following are some dis-

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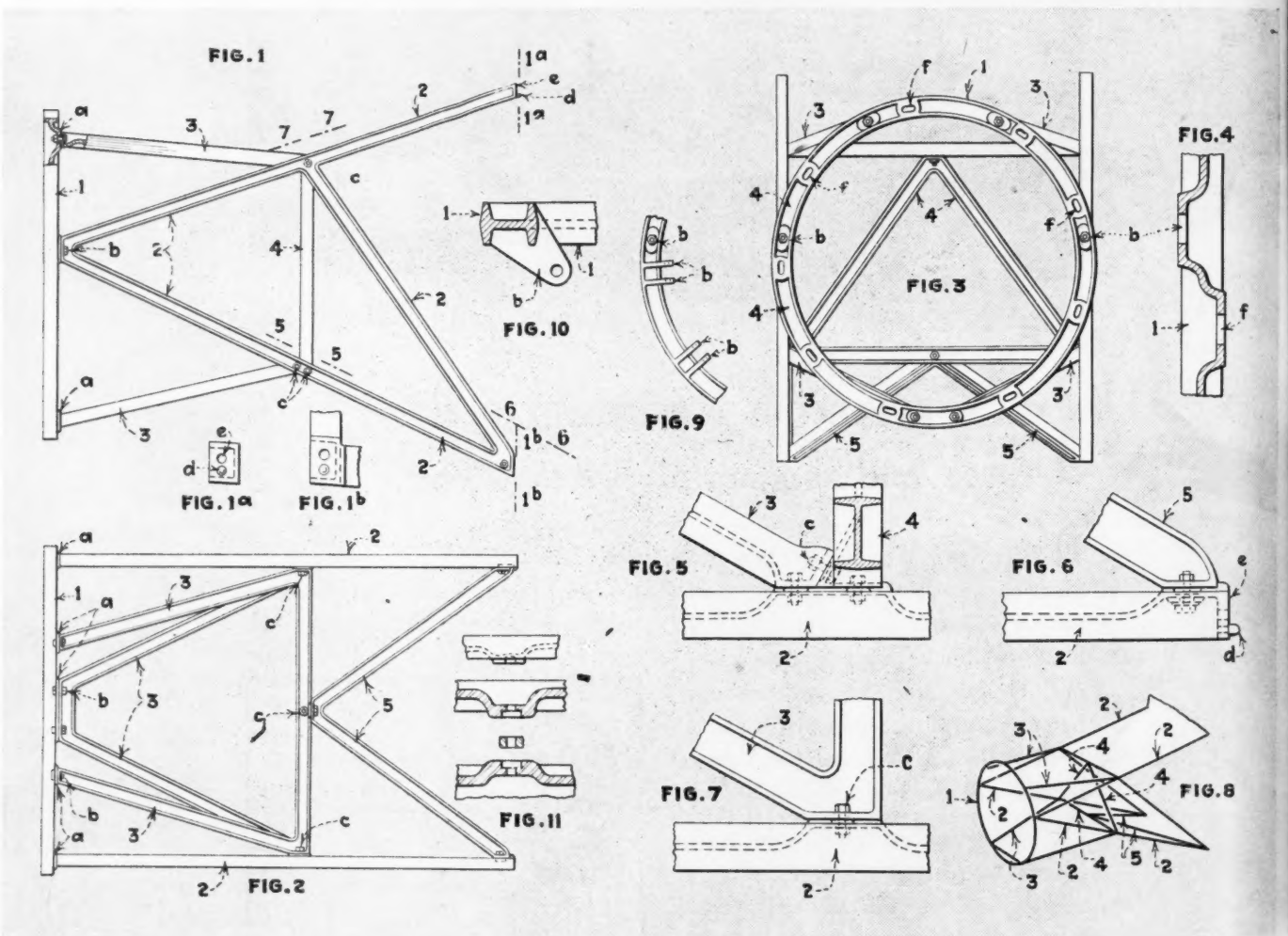


Fig. 1. Side elevation of forged engine mount.
Fig. 1a. Detail view on line 1a-1a of Fig. 1.
Fig. 1b. Detail view on line 1b-1b of Fig. 1.
Fig. 2. Top plan view of Fig. 1.
Fig. 3. Front elevational view of Fig. 1.
Fig. 4. Sectional elevation on line 4-4 of Fig. 3, enlarged.
Fig. 5. Detail elevational view on line 5-5 of Fig. 1, enlarged.
Fig. 6. Horizontal section on line 6-6 of Fig. 1, enlarged.
Fig. 7. Elevational view on line 7-7 of Fig. 1, enlarged.
Fig. 8. Schematic view of mount.
Fig. 9. Rear view of part of mounting ring (1) showing another construction of this section.
Fig. 10. Sectional view, enlarged, of cross section of Fig. 9.
Fig. 11. Sectional details of attachment faces between frame members.

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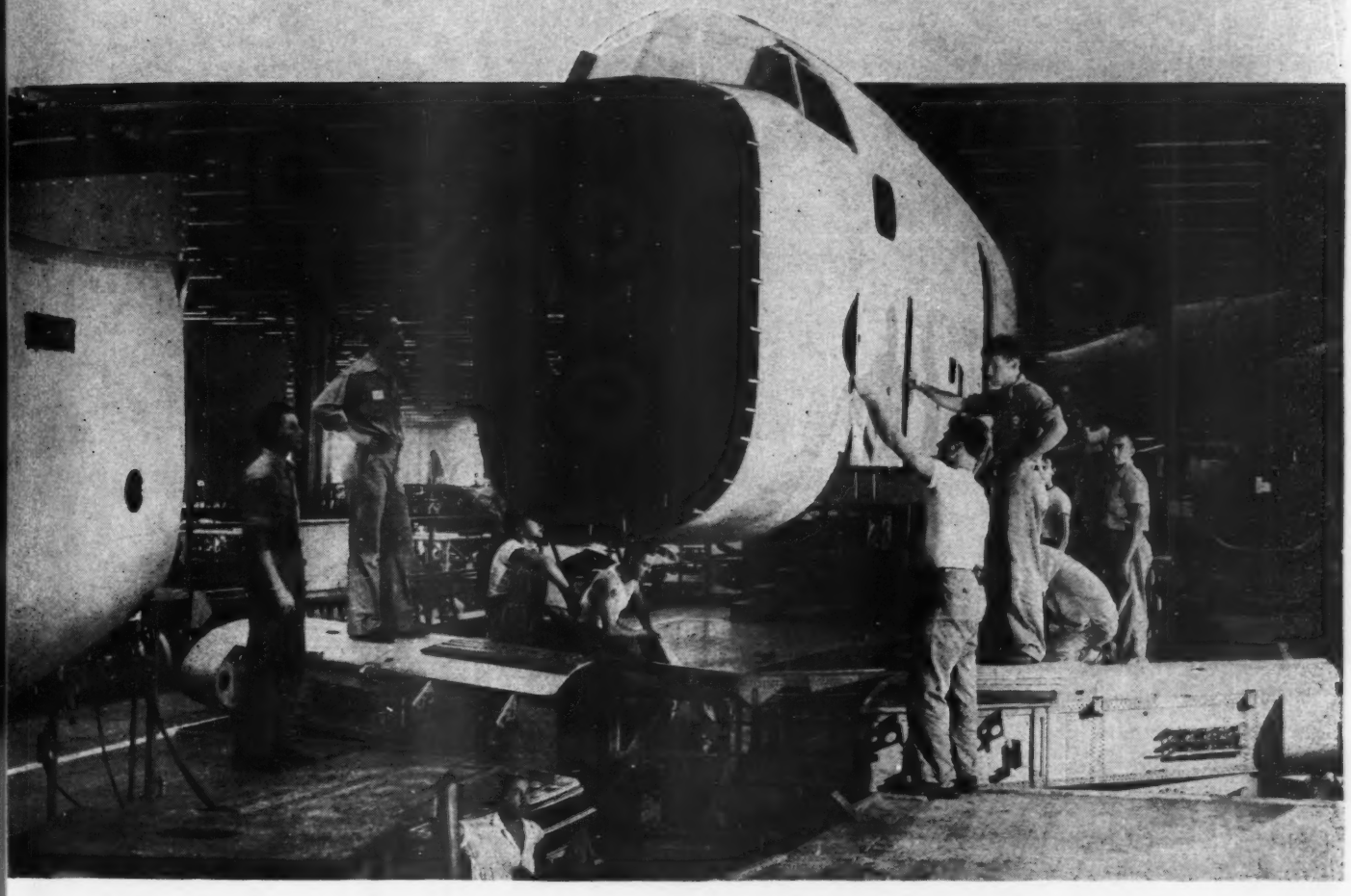
# Aircraft Tool Planning

## *Part II*

By **RICHARD H. LUDERS**, *Manufacturing Planner, Vega Aircraft Corporation*



**Farsighted tool planning determines volume, quality and cost of production, as well as manpower efficiency. The author here concludes his study with consideration of the remaining eight points essential to good tooling in the aircraft plant.**

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To RECAPITULATE, last month we discussed twelve points essential to good tool planning. These included ultimate part cost, system of coordination, attaching points (interchangeability), master tooling, importance of part or assembly, forming quality of specified material, necessary jigging, assembly location, complicated assembly structures, bench assemblies, production assemblies, and design requirements. To continue, the next point is:

### 13. Check Fixtures

In conjunction with major jigging and master tooling, check fixtures are often built to check the assembled structure itself. *This is a means for determining a source of trouble.* Should there be mis-alignment, mis-mating, incorrect contours, growth of the structure from riveting, strain within the structure (warpage and spring in the structure), etc., the check fixture can readily locate the trouble. Check fixtures are used on detail parts for hole location, hole size, or shape and contour of the parts. Check fixtures are usually left in the hands of the inspection department.

Use of check fixtures for a sheet metal assembly are not always apparent at the start, but as parts or assemblies are produced, if certain difficulties as named above arise, then check fixtures must be ordered. Check fixtures serve two more purposes: One, they are used to check the assemblies or ship itself, for hinge line alignment, clearances, or the swing or throw of a rudder or elevator, etc.; two, if an assembly is removed from a jig partially complete, and riveting and skinning is to be finished on a bench, a check fixture can be used to hold attaching points, brackets, hinge lines, or any vital sections that must not lose alignment during the finish riveting. If planning can forsee these problems, then much trouble can be averted. A thorough background of experience is an asset in determining the need for check fixtures.

### 14. Engineering Changes

America is foremost in the thought that changes in the aircraft structures, even during the manufacturing processes, are essential to the building of *superior aircraft.* Even though these engineering changes entail considerable

# TUBE TURNS

## CYLINDERS and PISTONS

## help engine makers 2 ways!

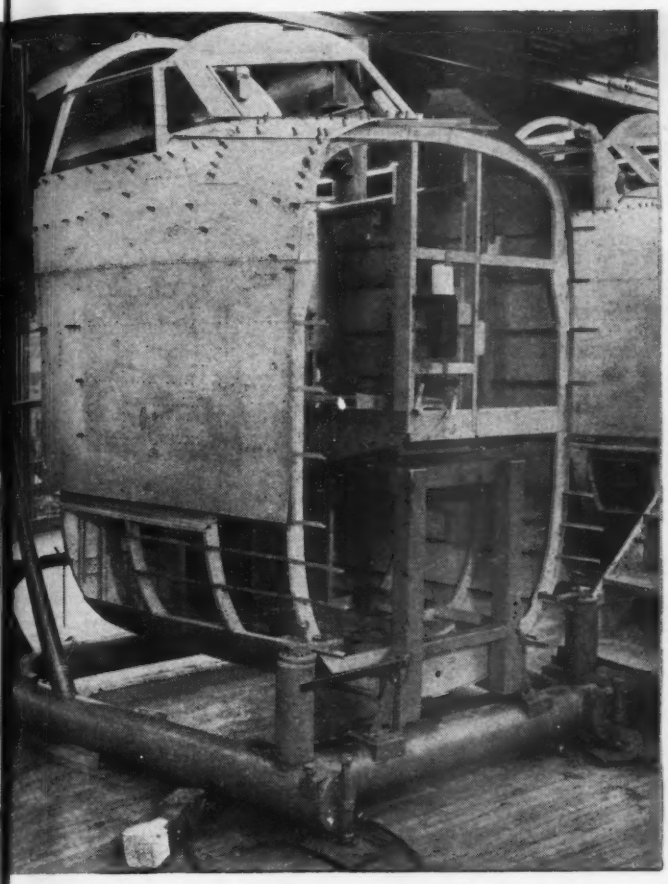
TUBE TURNS' cylinder and piston forgings in that engine—and thousands more—offer a ***double advantage*** to engine manufacturers. (1) The unusual ***speed-plus-precision*** with which Tube Turns forges these crucial parts ***helps engines reach assembly lines faster.*** (2) Tube Turns' ***ultra-modern*** forging methods give their cylinder barrels and aluminum pistons ***improved metal structure, added hardness*** and ***more heat resistance***—for longer life and dependable performance in engines.

**TUBE TURNS**

INCORPORATED

LOUISVILLE KENTUCKY

**CYLINDER BARREL AND ALUMINUM PISTON FORGINGS**



**New systems of tooling** have been built for greater efficiency of women operators. Easy accessibility to work eliminates fear and errors.

**ilot's compartment** in pick-up jig, which mainly to hold important units in posi-on during riveting. This relieves assembly g for assembling of framework and skins.

ooling and production work or rework, hey do tend toward better ships and id tooling and production. As proof of his, the enemy have "frozen" some of he designs of their ships, with the re-ult that today these ships are outmoded nd inferior to the everchanging and mproving, superior American aircraft.

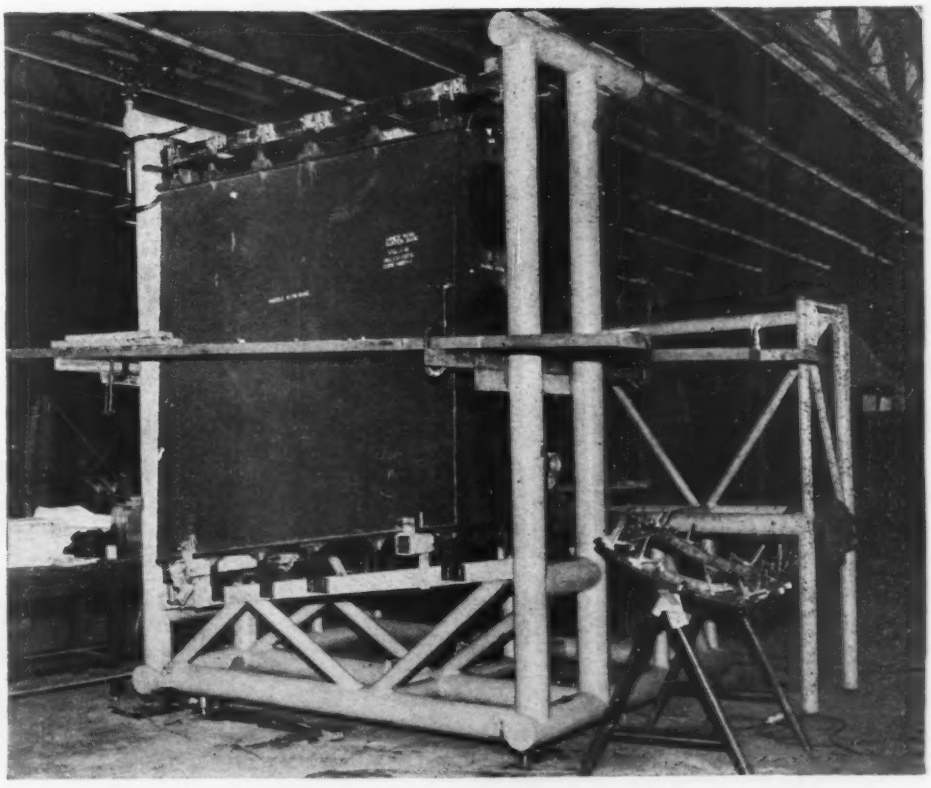
Changes are made by the engineers t the request of stress, lofting, tooling, r production departments; the Army r Navy (customer request); or the en-gineering design groups. All in all, hese changes will tend to strengthen the hips, improve the streamline qualities f the external surfaces, eliminate and vercome tooling difficulties (better de-igning for production), assist produc-ion with simple attachments and as-emblies, respond to the special desires nd specifications of the Army or Navy, nd always entail striving for superior lying characteristics.

As these changes are made, the tool lanning department receives forms engineering orders or tracing change otices) on each and every one that is fficial. All tooling affected must be eworked to conform to the new condi-ions, and at the time in the production program when the change is to take effect. Should the change take place on completed ships, the engineers make a disposition as to whether it is necessary to replace the part, rework it on assembly, or leave it as is.

### 15. Fabrication and Assembly Time

With speed an ever essential part of the production program, planning must consider tooling that will aid and assist output. In many cases, simple tooling is sufficient. The best way to handle the planning of a detail is to first consider all the available regular or standard cutting and forming machinery in the

(*Turn to page* 410)



**master gage** set in place to build accu-ately all locating points and positions into jig. Without these masters, interchange-bility cannot be attained.

# AIR-DESIGNED for Today and Tomorrow!

SINCE long before Pearl Harbor, the name BENDIX RADIO has stood for one thing: the finest precision-built aircraft radio equipment available. Proof of the superiority of this highly specialized equipment is its operation at extreme ranges of temperature, humidity, altitude... and its use in virtually all military aircraft of the United Nations.

In recent years, production of "BENDIX" Radio Equipment has been many times multiplied. And important advances in BENDIX RADIO engineering have paralleled this progress in production.

Out of them have come many new electronic developments in communication, navigation and detection to help speed Victory. From the vast store of experience thus being constantly gathered will come equally great accomplishments to smooth the paths of Peace.

## BENDIX RADIO DIVISION

"BENDIX" Radio Equipment is a vital member of "The Invisible Crew" — precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

THE INVISIBLE CREW
Precision Equipment by
Bendix
AVIATION CORPORATION

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## Engineered Into the Products of Today . . . and the Future

Time was when workmen loved to refine and polish their work to a high degree—for the pleasure it gave them. Their hearts were in it.

These craftsmen of old could not even imagine the functional soundness and extreme accuracy which we are building into Dole Aircraft Valves and Fittings. Nevertheless some of their craftsman attitude goes into this highly modern product.

When our customers—among the Aircraft Industry's leaders—have time to comment, they tell us "Dole quality is unsurpased." That's a way of saying our hearts—and heads—are in our work.

Against the day when you will need engineering services to assist both in the design and production of precision valves, fittings and accessories, remember us.

*Made In Accordance With Army-Navy Aeronautical Standards.*

**THE DOLE VALVE COMPANY**

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★

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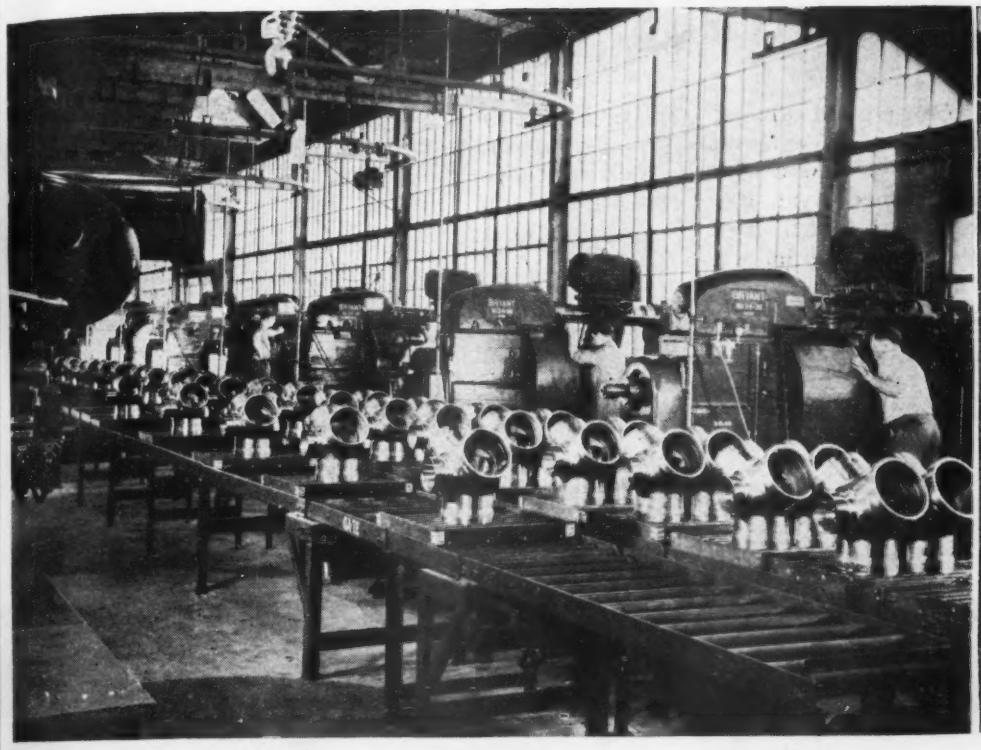
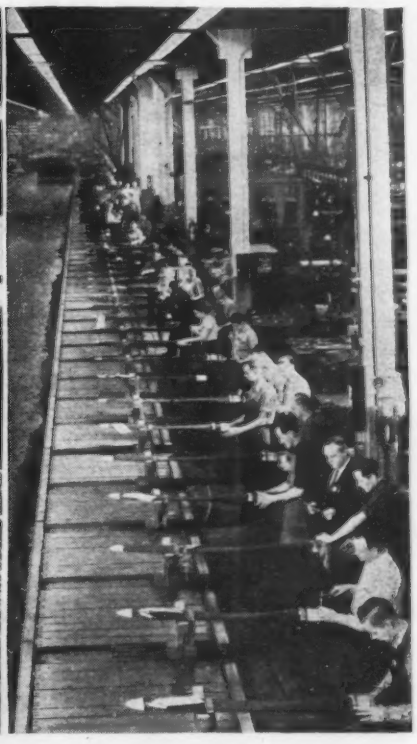




*All photos are by Curtiss-Wright Corp. Propeller Div.*

**Hubs are conveyed** to grinding department for grinding barrels and cone seats. Overhead electric hoists on rails carry parts to grinding machines. Continuous mechanical transportation of parts has eliminated nearly all hand trucking.

**This slat conveyor** saves much time in assembly of gears and bearings with the blades. Parts arrive at assembly stations by overhead monorail.

# New Curtiss-Wright Propeller Conveyor-Assembly Line

A HIGHLY MECHANIZED CONVEYOR and assembly line for increased propeller production was recently completed at Curtiss-Wright's Indiana plant, which is on the site of the old Marmon factory that produced *Liberty* aircraft engines in World War I. The new building is air conditioned, extremely well lighted, and windowless to aid in uninterrupted blackout production.

An extensive conveyor line handles nearly all transportation of parts from start to finish. Overhead monorails carry finished parts from stockrooms to assembly stations, and small subassemblies travel on slat and roller conveyors. Parts are sent through anodizing and dichromate tanks by overhead carrier, removed from this line at a transfer station and put on the paint conveyor, which also comprises an overhead rail. This takes them through a set of automatic paint-spray booths, with paint mixed and distributed from a central control station. From here the line passes through batteries of infra red drying lamps, which greatly speed the process.

Final assembly proceeds on slat conveyors, leading to the balance department where all propellers are statically balanced. Upon completion here, units are partially disassembled and carried to the shipping department, being automatically weighed in transit. Here the propellers are crated and carried to a crane which loads them into railroad cars to send them on their way.

The old plant was first taken over in February of 1941. The new and largest unit was begun in February of 1942.

**Final balance section.** These propellers will pull P-47's and B-26's.

# THE SHAPE OF THINGS TO COME...

Perhaps you see only a giant exhaust collector ring for a twin-row engine. Actually you are pre-viewing a new and exactingly designed Ryan Exhaust Manifold System that insures the high standard of performance demanded of a certain American military combat plane.

In addition to their prime job of discharging exhaust gases and heat, Ryan manifolds are being developed to dampen exhaust flame, power turbo-superchargers, transfer heat for carburetion, cabin heat and wing de-icing.

As the only major aircraft manufacturer with an important division devoted to volume production of exhaust manifold systems, Ryan molds the shape of many things to come in the vital field of heat transfer engineering.

Exhaust Systems Manufacturing Division
**RYAN AERONAUTICAL COMPANY**
San Diego, California
Eastern Office, 420 Lexington Ave., N. Y.

# POINTS ON PLASTICS
# In Aircraft Engineering*

***Part II***

By **JOHN SASSO**, *Product Engineering*

**Plastics are "taking to the air" in strikingly increasing number. Comparative properties of these materials are dealt with by the author in this second article of his timely series presenting pertinent data on engineering and production of plastic components for aircraft.**

HAVING NOW CONSIDERED the fundamental factors (Part I, Apr. AVIATION) which should be investigated prior to designing an aircraft component wholly or in part of plastic material, we now continue with an examination of the comparative properties.

First off, let us say that comments on properties and characteristics of the various plastics are offered only as a means for quick, comparative study. This word of caution is necessary because atmospheric conditions, operating conditions, formulation, molding, and curing will, to a greater or lesser extent, influence the behavior of plastics in service.

The engineer should make it a fundamental rule, after first studying the specific plastic material he is considering for possible inclusion in his design, to get full information on that material from the manufacturer, with particular reference to what test conditions were used to determine physical, chemical, thermal, and electrical values. In this connection, the ASTM has published plastics specifications and testing standards accepted throughout the industry.

Consultation with an experienced molder before final design prints are made will repay the engineer in many ways. The molder knows how various materials will behave under fabrication, and whether it is economically feasible to use the desired fabrication process. Further, he may be in a position to suggest slight changes in design that will speed production and may reduce cost.

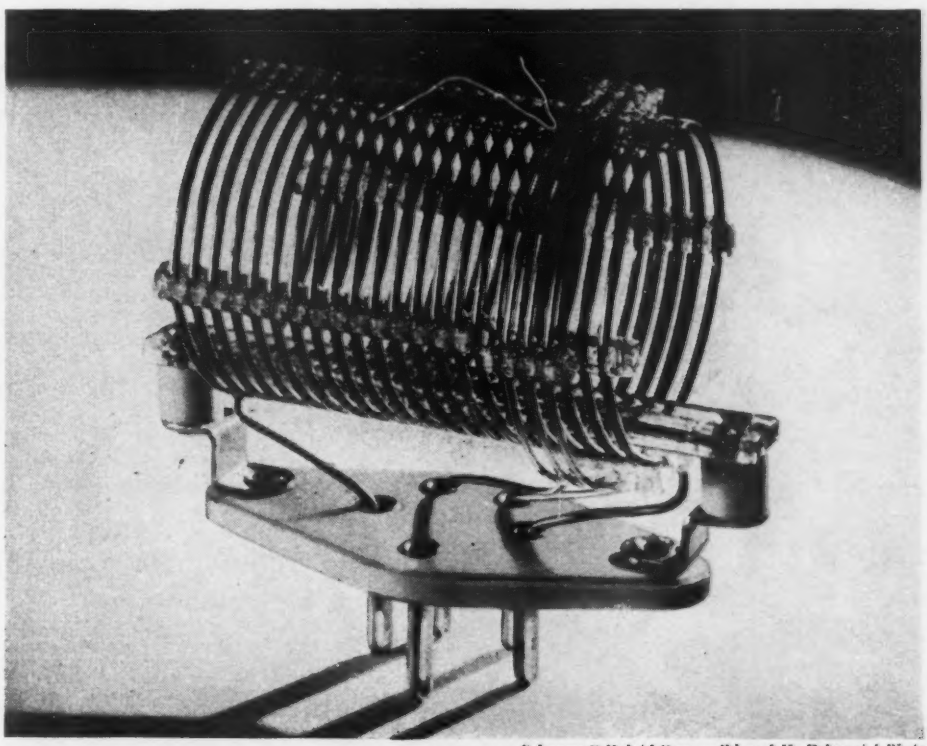
### Weight

On a weight basis, plastics offer the designer considerable advantage over metal, but they can never be selected on a weight basis alone. Advantage can be taken of the high strength-weight ratios of plastics in the design of component parts for aircraft and transportation equipment. In aircraft, plastics are successfully used in non-structural applications such as flooring, conduits, and pulleys. Acrylic sheets, for cockpit and "blister" enclosures, are standard not only because they have less than half the weight of glass but also because they can be easily formed to complex shapes. Where moving parts reverse direction, inertia forces are set up and plastic parts often help solve the problem of attendant vibration (see Table III in Part I of this series, page 143, Apr. AVIATION).

### Tensile Strength

This is one of the properties of a plastic material that is subject to considerable variation, depending on manufacture, molding technique, degree of polymerization, amount and kind of fillers and plasticizers present, temperature,

**Laminated plastic** has replaced aluminum in making of this aircraft seat. Material is cotton fabric laminated with phenolic resin.



*Celanese Celluloid Corp.—Edward H. Rehnquist Photo*

**Affording good electrical and mechanical properties,** Lumarith (cellulose acetate plastic) is employed in this induction coil used for tuning radio frequency circuits. For insulation, plastic has been incorporated at four different radial points of unit.

*Based in part upon key chapters in the author's new text, *Plastics for Industrial Use*, published by the McGraw-Hill Book Co.

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White-Rodgers automatic temperature modulation equipment relieves pilots for greater concentration on fighting power by providing completely automatic control of:

1. **Engine cowl flaps (both air and liquid cooled).**
2. **Oil cooler shutters or flaps.**
3. **Cabin temperature (both super-charged and normal).**
4. **Carburetor air temperature.**

Upon request, engineering data will be furnished to manufacturers requiring controls for the above or other temperature control applications.

## WHITE-RODGERS ELECTRIC CO.

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THE AVENGER—TORPEDO BOMB
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and moisture. It may be said generally that plastic materials develop tensile properties during formation of the molecular structure of the resin. Where polymerization takes place during molding, as in the phenolic and urea resins, tensile strengths will depend to some extent on molding technique. Undercuring will reduce tensile strength. Flow lines caused by non-uniform flow in the mold may be the starting points for mechanical failure. Internal strains in the molded part impair the physical properties.

In thermoplastic molding, weld lines may appear. These marks occur where the mold design is such that the plastic is forced to separate on either side of the mold and then to reunite. Unless care is taken in design of the mold and in selecting material of proper flow characteristics, this region in the finished part may be considerably lower in strength than the rest of the piece.

Fillers and plasticizers are important factors in determining strength and serviceability of the finished molded piece. Fillers have great effect on impact strength, flexural strength, and flow. Plasticizers which are added to thermoplastics to obtain desired flow properties will affect strength of the molded part. When certain molding qualities are obtained, tensile properties will usually deteriorate. The acetates with the best flow show the lowest strength, and vice-versa.

Temperature has a marked effect on physical properties. Except in highly-stressed parts, or in applications where extreme ranges of temperature must be met, engineers generally do not investigate changes in the physical properties of metals with temperature. With plastics, even small changes in temperature will cause variation from the tabulated properties of the materials, particularly the thermoplastics. For instance, tests have shown that one type of polystyrene which has a tensile strength of 5,000 lb. per sq.in. at 175 deg. F., has a tensile strength of 8,000 lb. per sq.in. at —4 deg. F. On the other hand some plastics lose strength rapidly as temperature increases. Thus temperature-sensitivity characteristics of plastics are extremely important and will bear considerable study by the design engineer. Conditions under which the plastic part must operate should be very carefully anticipated. Ambient temperature in particular should be taken into account. Humidity also affects strength. As a general rule, it will be found that as plastics absorb moisture they will show a small reduction in tensile strength. (See Table II on strength properties of plastics, page 143, Apr. AVIATION.)

### Compressive Strength

Laminated phenolics, particularly those which are canvas-reinforced, have high compressive strength—a characteristic which has led to their adoption as washers, gears, bearings, and to their use in certain machinery applications. In molded parts, best compressive strength is shown by wood-flour filled phenolics and furfurals. Thermoplastics have distinctly lower compressive strengths. Temperature affects compressive strength much as it does other physicals. For parts in which heavy loads must be taken, many designers mold thermoplastics over metal inserts which take a considerable part of the load.

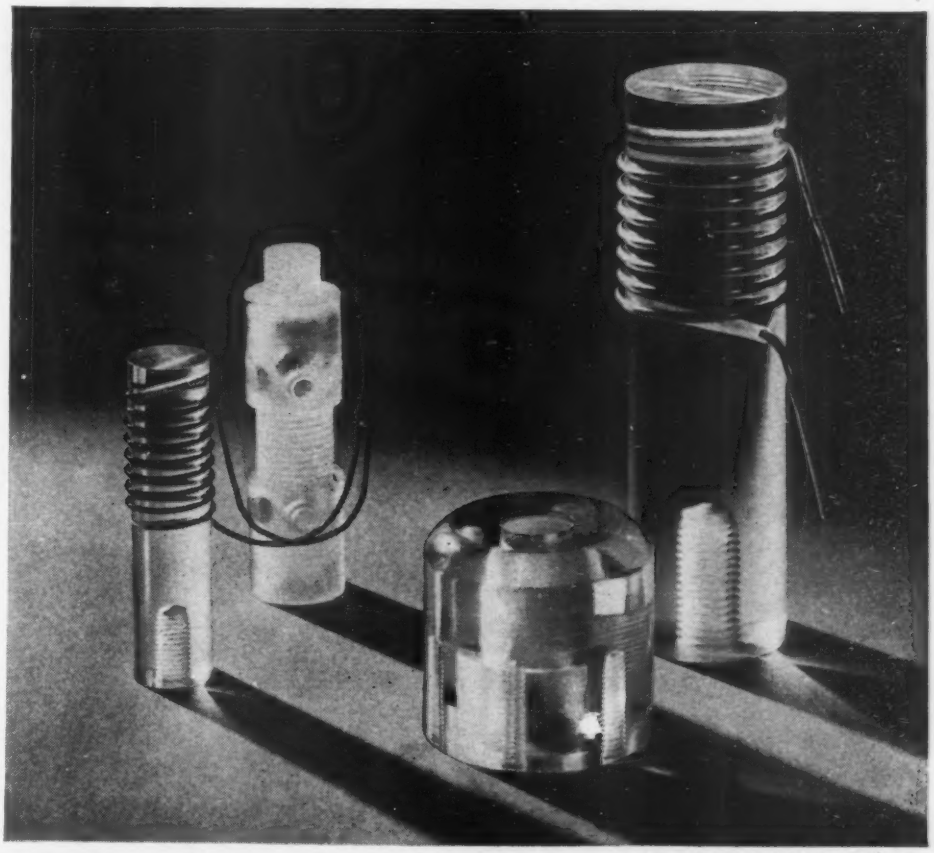
**Plastic Parts for Aircraft**

| | |
|---|---|
| Aileron control crosses | Fuel gages |
| Antenna housings | Guides |
| Antenna masts | Inspection hole grommets |
| Antenna mast supports | Instrument cases |
| Antenna reel cases | Insulating washers |
| Bearings | Insulators |
| Berth-light fixtures | Knobs (heat, carburetor heat, control stick, throttle, and radio) |
| Bumper plates and stops | Lamp boxes |
| Bushings | Landing light covers (in wings) |
| Buttons | Name plates |
| Button fittings | Nose wheel steering wheel plugs |
| Cabin ventilator fixtures | Panels |
| Cable guards | Protective sheets |
| Cable seal fairlead tubes | Pulleys |
| Chafing strips | Quadrant cable tracks |
| Coil parts | Radio direction finder housings |
| Compass housings | Radio masts (base, mast, cap) |
| Conduits for electric wiring | Rubbing strips |
| Conduit supports | Sight gages |
| Control column wheel hubs | Signs (illuminated) |
| Control pulleys | Spacers |
| Control quadrants | Switch housings |
| Distributor parts | Terminal blocks |
| Dome light lenses | Terminal strips |
| Drain hole grommets | Trim tabs |
| Ducts | Tubing |
| Dust covers | Wash basin splash boards |
| Engine control fairlead grommets | Window frames |
| Engine cowl flap connectors | Window panes |
| Fairleads (all sizes and shapes) | Windshields |

### Impact Strength

Fillers and plasticizers play an important part in determining the impact strength of plastic parts. In phenolics, fibrous fillers increase impact strength; in thermoplastics, greater proportions of plasticizer improve impact characteristics. For example, a molded phenolic with long fabric filler has approximately ten times the impact strength of wood-flour filled, three times the impact strength of cotton-filled, and twice the impact strength of shredded-fabric filled phenolic. Certain formulations of ethyl cellulose, cellulose acetate, and cellulose acetate-butyrate show high impact strengths.

A word of caution should be introduced here to point out that again operating conditions, particularly of temperature, must be especially considered when impact strength is a vital factor in part design. Some thermoplasties become brittle at low temperatures and lose impact strength. At high temperatures, volatilization of the plasticizer may make the molded part brittle,



*Nick Lazarnick Photo*

**Made from Lucite,** these coil forms and insulators are used on mobile high-frequency radio operated by our military forces. Cast methyl methacrylate rods are easily machined into required forms.

**TABLE IV. THERMAL PROPERTIES OF PLASTICS**

| | Thermal Conductivity $10^{-4}$ Cal./Sec./Sq. Cm./Deg. C./Cm. |
|---|---|
| Phenolic | |
| Wood flour | 4–12 |
| Mineral | 8–20 |
| Macerated fabric | 3–5 |
| Cast phenolic | 3–5 |
| Laminated Phenolic | |
| Paper | 5–8 |
| Cotton | 5–8 |
| Asbestos | 7–9 |
| Phenol Furfural | |
| Wood flour | 3–5 |
| Mineral | 10–20 |
| Fabric | 5–8 |
| Urea | 7 |
| Vinyl Chloride | 4 |
| Vinylidene Chloride | 2.2 |
| Methyl Methacrylate | 5–7 |
| Polystyrene | 1.9 |
| Ethyl Cellulose | 3.8–6.3 |
| Cellulose Acetate | 4.5–7.8 |
| Cellulose Acetate-Butyrate | 4.5–7.8 |

**TABLE V. ELECTRICAL PROPERTIES OF PLASTICS**

| | Dielectric Constant 60 Cycles | Dielectric Strength Short Time Volts/Mil 1/8-in. Thickness | Power Factor 60 Cycles |
|---|---|---|---|
| Phenolic | | | |
| Wood flour | 5–12 | 300–500 | 0.04–0.30 |
| Mineral | 5–20 | 250–400 | 0.01–0.30 |
| Macerated fabric | 5–10 | 150–450 | 0.08–0.30 |
| Cast Phenolic | 6.5–7.5 | 350–430 | 0.10–0.15 |
| Urea | 7.6–8.6 | 650–720 | 0.04–0.055 |
| Vinyl Chloride | 3.3 | 400 | 0.008 |
| Vinylidene | ..... | 500 | ..... |
| Methyl Methacrylate | 3–5 | 500 | 0.03–0.08 |
| Polystyrene | 2.5–2.6 | 500–700 | 0.0001–0.0003 |
| Ethyl Cellulose | 2.7 | 400–700 | 0.007 |
| Cellulose Acetate | 3.5–6.4 | 290–600 | 0.01–0.06 |
| Cellulose Acetate Butyrate | 3.5–6.4 | 250–400 | 0.01–0.06 |

reducing impact strength. If temperature is further increased, softening may occur. Phenolic parts show considerable reduction in impact strength at temperatures of 200 deg. F. and above.

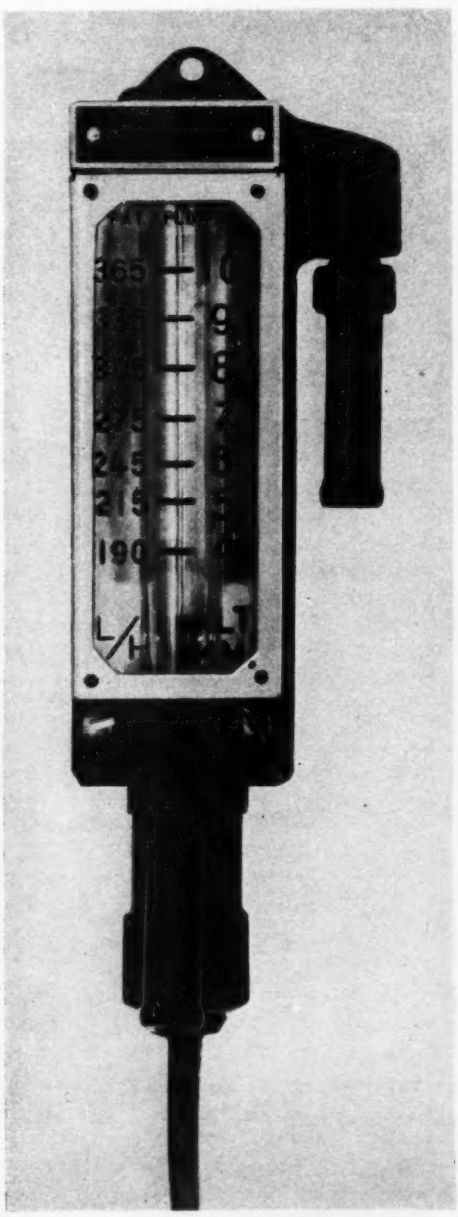
Impact characteristics of a molded part are greatly dependent on proper design. Obviously, if a part is subjected to repetitive impact, failure will occur at lower stresses than under static loading. It is generally good practice, when designing, to employ a factor of safety of at least 3 for impact calculations based on strength tables for the various materials.

### Thermal Properties

As previously stated, the broad classifications of thermosetting resins and thermoplastic resins do not serve as indications of the thermal properties of plastics. Generally speaking, plastics have relatively low thermal conductivity. This characteristic is valuable for certain applications such as electrical equipment, knobs and plugs, and steering wheels. It is this property which accounts for the "pleasant touch" so much referred to in describing the advantages of plastics. Low thermal conductivity is often taken advantage of in industrial applications where the plastic used also furnishes good structural and electrical qualities.

It is important in design to determine the maximum temperature to which the part will be subjected. Proper measures taken during design may avoid failures due to temperature. Temperature may cause changes in physical dimensions because of softening; it may also increase creep and cold flow, and cause dehydration or volatilization of the plasticizer. The heat distortion point, as determined by standard test, serves as a criterion.

As a matter of caution, it is well to consider that the greater the stress in a part, the lower the safe temperature of operation. Along with the heat distortion point, the engineer should investigate the effect of that temperature on other properties of the plastic. Some may, like ureas, have a heat distortion point of 260 deg. F., yet urea embrittles at temperatures over 170 deg. F. Other plastic materials may lose color or suffer reduction in dielectric strength.




**Precision molded** and tapered Lucite tube, housing red Lucite float, is incorporated in this oxygen flow meter. Included is calibrated window of same material. Entire unit is mounted in lightweight forging.

Thermal expansion is a particularly important design factor for products combining plastics and metals, particularly where mating parts are concerned. Shrinkage and expansion for a given temperature differential are considerably greater in plastics than in metals. Thermal expansion must be considered in relation to chemical changes which occur with aging and heat, such as dehydration, volatilization of plasticizer, and even further polymerization. These will all cause slight shrinkage when they occur. The effect of these variables can be minimized by proper design.

By study of the data presented, it will be found that temperature has a decided effect on other properties of plastics—impairing electrical properties, lowering chemical resistance, and exerting, as mentioned previously, considerable influence on physicals. (See accompanying Table IV.)

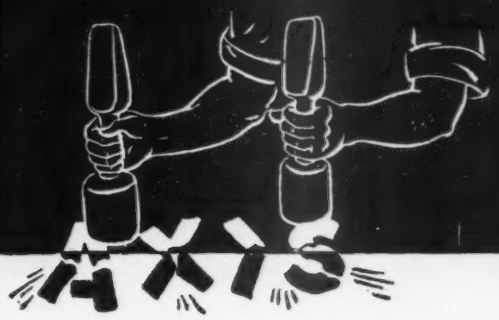
### Electrical Properties

Plastics are used in many electrical applications: Radio, signal, and transmission parts, aircraft and switch mountings, telephone equipment, industrial controls, and housings. In many cases they serve structural, insulating, and appearance purposes, in addition affording the designer advantages of quick assembly and good sales-appeal.

Electrical properties in service life of plastics used for molded parts depend to a great extent upon proper design, operating temperatures, and conditions of humidity. Many times it will be possible, by proper design, to obtain better electrical performance of the part. Generally speaking, high operating temperatures adversely affect electrical properties. For example, dielectric constants of the phenols change considerably with rises in temperature. At high operating temperatures, dielectric strength is adversely affected, as is insulation resistance.

The amount of moisture absorbed by

(*Turn to page* 360)

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Our quality sand and permanent mold aluminum castings are helping many producers of finished and semi-finished war materials to keep the "Situation Well In Hand" on the production front. Over thirty years of experience, thorough research, careful supervision and unmatched craftsmanship have made us one of the largest producers of sand and permanent mold aluminum castings. TENUAL Aluminum Castings are meeting today's demands—assuring tomorrow's needs.

**TENUAL**

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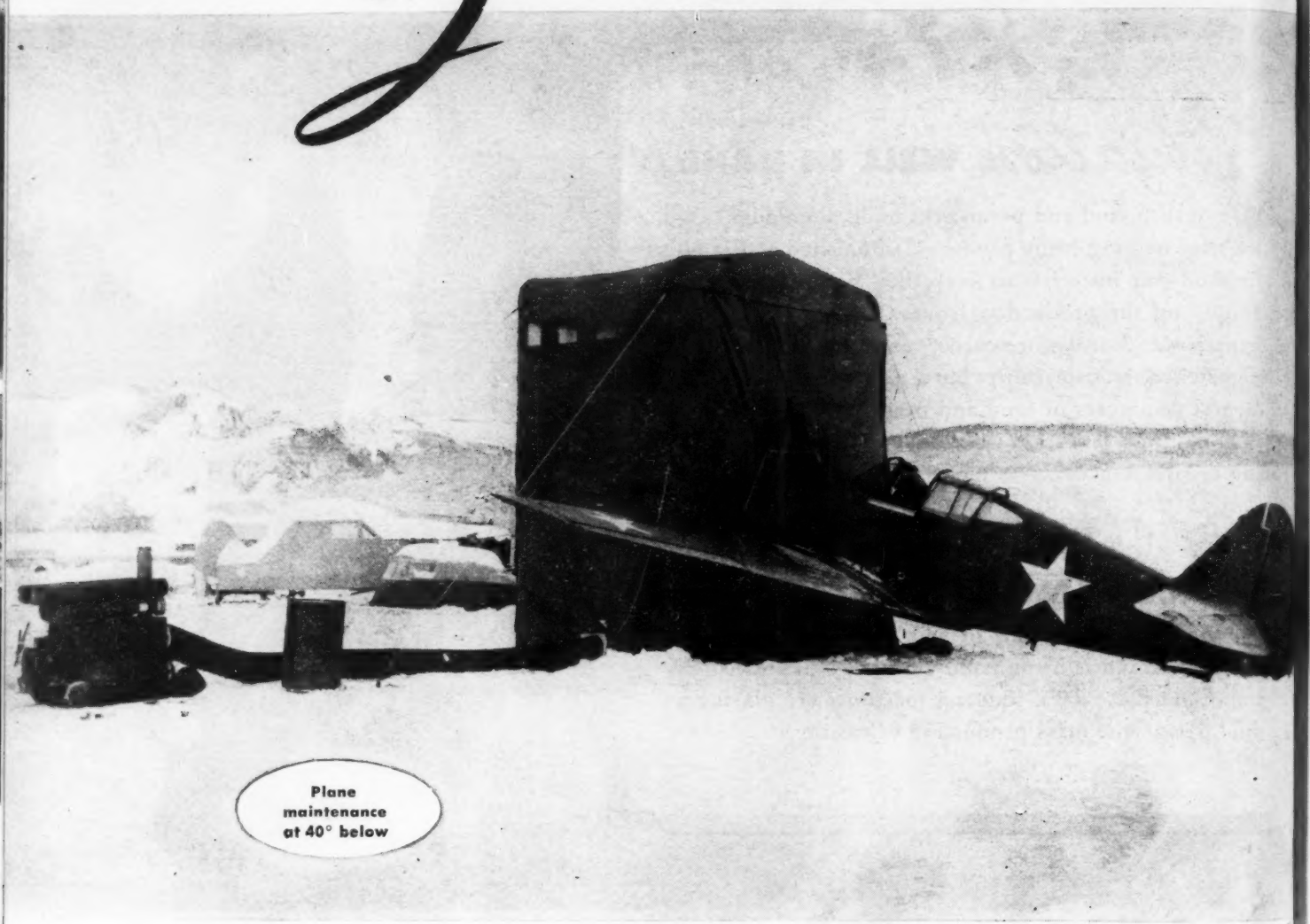

Plane maintenance at 40° below

Official Photo U. S. Army Air Co

You might say that this kind of zero is practically always on a fighter's tail! An immelmann or a barrel-roll won't shake it... ask the boys in Alaska, where engines have to be "pre-cooked" to the right temperature before they'll turn a prop.

Once started, the engines keep themselves warm ... *but*, control systems take a beating. This is why so much depends on the right kind of Ball Bearings! Tolerances and lubricants, for example, must allow for the abnormal reactions of materials at these unusual temperatures and still provide the sensitivity and rigidity that spells success in combat flying.

For more than a decade, aircraft engineers, builders and designers have unequivocally specified Fafnir Aircraft Ball Bearings as the *right* bearing for all-important control efficiency and dependability. Fafnir engineers have advanced "new" bearings to match every stride of America's forward-marching aviation industry. The Fafnir Bearing Company, Aircraft Division, New Britain, Connecticut.

ARMY (E) NAVY

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**Ball Bearings**
*for Aircraft*
*Engines and Controls*

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Eliminates rivets. No flux or solder required.

### INCREASED PRODUCTION

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### FEWER REJECTS

Accurate control of timing eliminates weak welds and burned material.

Electronic control is a natural partner for resistance welding. It gives micro-accuracy in the variables that go into making strong, precision welds—weld time and heat. It controls high currents noiselessly, efficiently.

Westinghouse supplies all the necessary equipment for electronic control of resistance welding. Two typical units are illustrated above, mounted on a spot welder.

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## RESISTANCE WELDING CONTROLS

# Theory and Technique Of Perspective Projection*

## Part IV

By GEORGE F. BUSH, *Assistant Professor of Graphics, Princeton University*

**Perspective engineering illustrations are increasingly favored on aircraft production lines—creating a wide demand for personnel trained to make these drawings. Concluding the author's series on graphical projection, this article deals with interiors, expedients, and pseudoperspectives.**

BECAUSE THEY REVEAL essential shape and basic component parts at a glance, pictorial drawings and sketches employing isometric, oblique, and perspective projections have, generally, been found significantly superior to conventional orthographically projected engineering drawings where shape description is sought.

Little or no training is required to read these pictorial presentations, hence the aircraft industry, broadly expanded with new workers, is finding perspective projection of growing importance. There is a consequent demand for personnel trained to execute these drawings.

Here, in our concluding article of this series we will consider interiors, expedients, and pseudoperspectives. Once more the reader is advised to check the prior installments (Jan., Mar., and Apr. AVIATION) for explanations of the steps discussed heretofore. And Methods 1 and 2, which are again dealt with in the following, will be found detailed on page 125 of Part I in the January issue.

Initially, let us refer back to Fig. 19 (page 174, Apr. AVIATION). Note that this perspective is somewhat distorted in that the wider *GF* portion of the wing appears to be smaller in the perspective than the narrower portion *BE*. This is due to the position of the wing portion relative to *PP* and also to the fact that the *SP* is too far to the left in the top view. Recall that the *CV* should always lie somewhere in the center of the final perspective, if excessive distortion is to be avoided. The distance of *SP* from *PP* should, roughly, be at least twice the longest dimension of the object.

Some authorities prefer to say that the object should be included in an angle of about 45 deg. subtended at *SP*. In any case, the basic idea regarding the position of the *SP* is that the projected perspective—when viewed by an eye at the scaled position of *SP* in front of the drawing (the *PP*)—should be that which the same eye would actually see without turning the head and by looking almost, if not directly, at the object.

When this principle is violated, as when the *SP* is placed too close to *PP* in the actual projection, the resulting distortion is like that shown by the light-line figure in Fig. 11 (page 151, Mar. AVIATION) where $(SP)'$ is too close to *PP*.

This now brings us to one last suggestion regarding the position of *SP*—concerning interiors in perspective. Since an interior is seen from the interior, always keep the *SP* within the confines of the interior. This is demonstrated in the accompanying Fig. 20, the common perspective of the interior of a bomber fuselage, showing various bomb-bay levels, and in which the *SP* is seen to be located in the interior, exactly on the longitudinal vertical plane of the bomber fuselage.

After satisfactorily locating the *SP* in the interior, and from the *PP* which cuts the object, Method 1 will, in general, be found best for locating enough perspective points to complete a satisfactory interior perspective. If the perspective is of the simple one-point variety, the *VP* on *HL* of all horizontal lines can easily be determined, and a combination of Methods 1 and 2 will be found best, if it is assumed that the longitudinal stiffeners are substanitally horizontal and that the fuselage cross-section is constant for the short length of fuselage under consideration.

The perspective of each of the three frames shown—240, 300, and 360—is obtained by direct projection of Method 1, Frame 360 in the top and end views could not be included on the available working space. The circle of vision, which is the intercepted area of the cone of sight by *PP*, is drawn in order that only the undistorted portion of the perspective may be used.

* A book, *Engineering Sketching*, is being prepared by Prof. Bush for early publication.

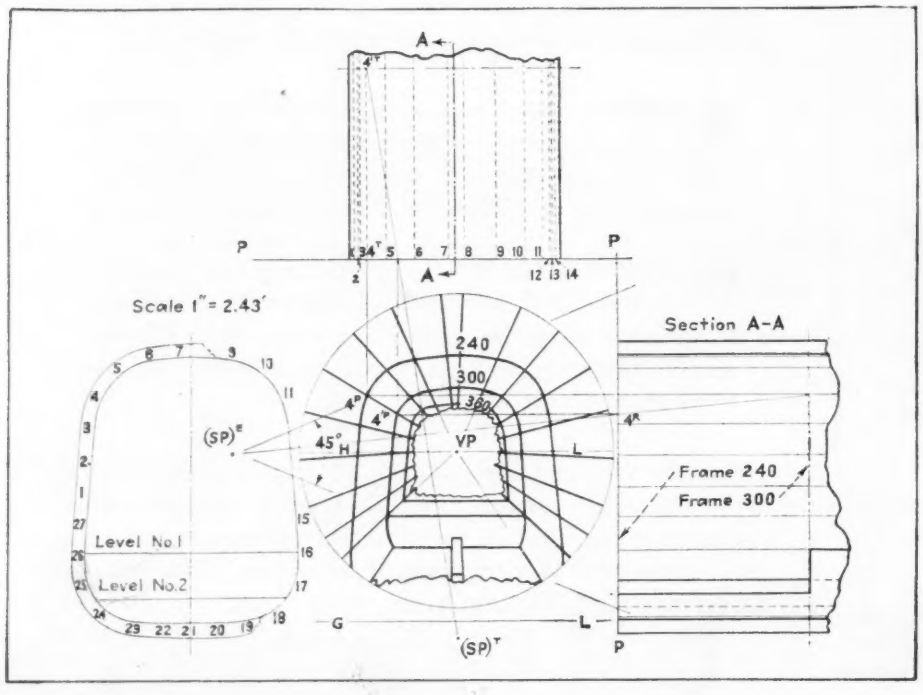
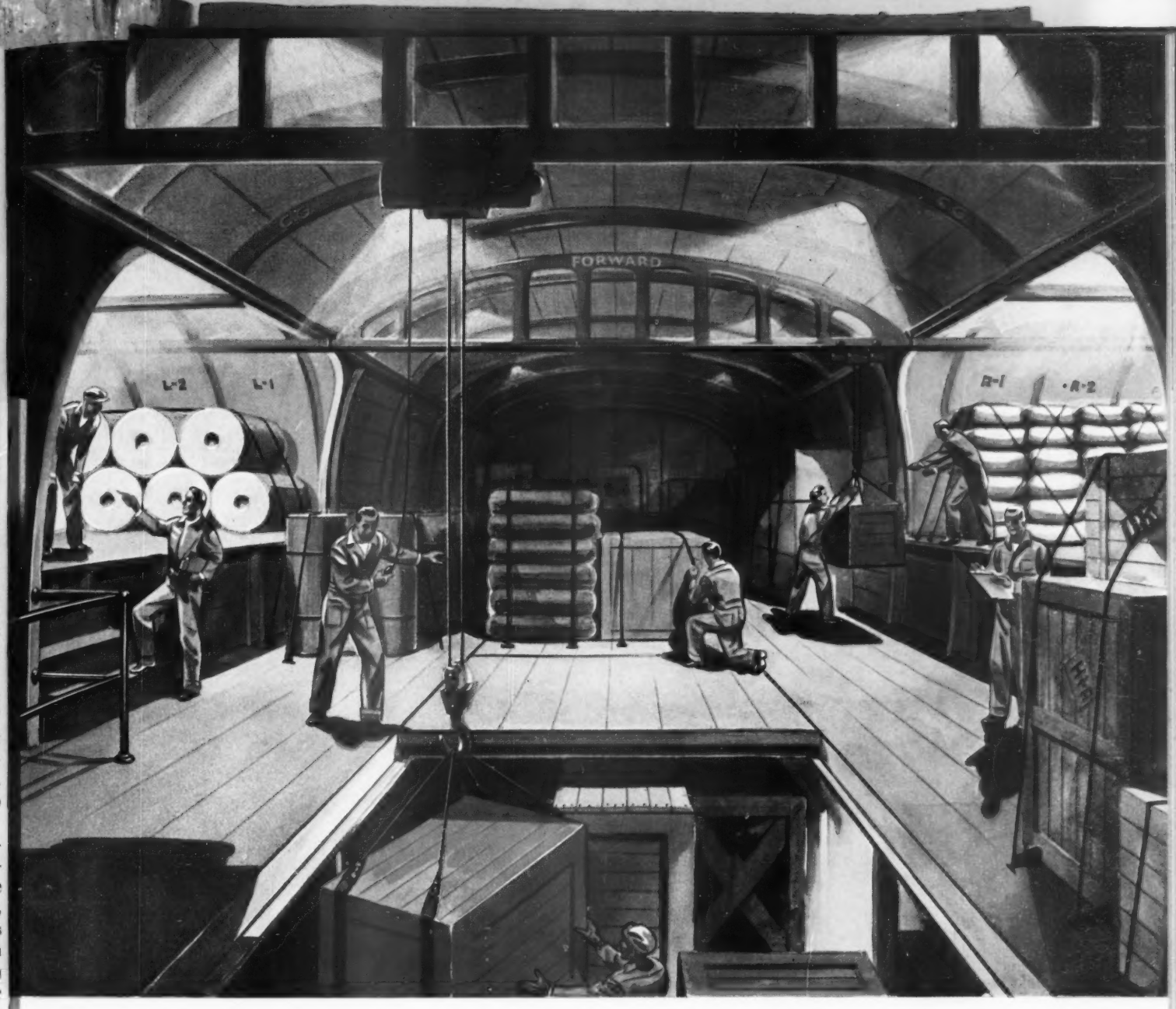



**Fig. 20. Common interior perspective** of section of a bomber fuselage (Case 1, Methods 1 and 2).

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# *Alloys in* ENGINEERING STEELS

When chromium, silicon, manganese, molybdenum, tungsten, nickel, or vanadium are added to a plain carbon steel, the steel acquires new properties. Depending on the alloys added, and the amount, the steel is made stronger, tougher, harder, more heat-resistant and more corrosion resistant. Such steels are called alloy steels. When these steels contain less than 5 per cent alloy and are used for mechanical parts, they are usually known as engineering steels. Shown here are some typical uses of engineering steels.

Minimum effective amounts of these alloys, largely obtained from scrap, are used in the wartime alternate National Emergency steels, which are in many cases satisfactory substitutes for the standard alloy steels.

However, because of service conditions in many applications, the standard steels of higher alloy content must be used. In ball bearings, for example, where abrasive wear is a problem, the usual steel is SAE 52100, which contains 1.2—1.5% chromium and 0.30—0.50% manganese.

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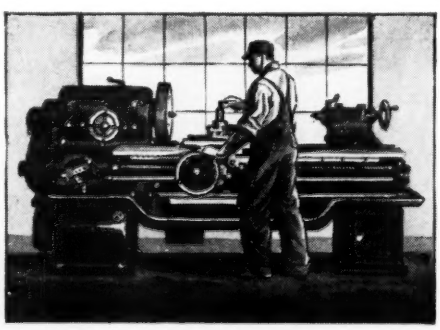
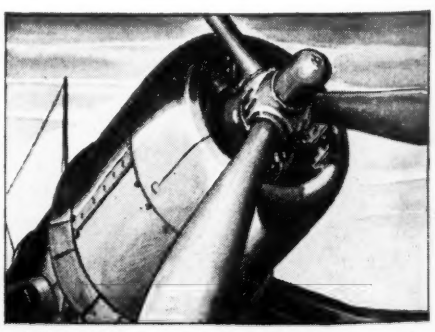
***Petroleum Equipment*** **. . . Pressure vessels, pipes, draw works shafting, drill collars, kelly bars, rotary table shafts, slush pump rods, and tool joints are usually made of engineering steels.**



***Machine Tools*** **. . . Engineering steels are used for precision lead screws, spindles, toolholders, gears, collets, feed fingers, cams, shaftings, pneumatic toolholders and pistons.**



***Planes*** **. . . Propeller blades and shafts, connecting rods, shafts, rocker arms and gears, cylinder liners, tubing, hydraulic parts, and structural parts are made of engineering steels.**

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A brief outline of the procedure used in obtaining this interior perspective now follows, with reference to Fig. 20:

1. On tracing paper placed over the engineering drawing, where end and top views will be used, draw the top and end views of *PP*, *GP*, and *SP*, locating *SP* to scale. For example, in Fig. 20, *GP* passes through the lowest point on the inside edge of the frames, and *SP* was located at a point 5 ft. 3 in. above *GP* to the scale 1 in. equals 2.43 ft. (The interior height of the frame is therefore 8.4 ft.) *SP* was also placed 10.02 ft. in front of the *PP* so that the cone of vision contained the fuselage to be shown in perspective.
2. Determine, by Method 1, the perspective of a point in a horizontal stiffener and in a frame. For example, an end view of a sight line to Point 4 in Frame 240 pierces the end view of *PP* at $4^E$. (The auxiliary view at the left side of the drawing shows the location of Point 4 in the frame.) The top view of the same sight line pierces the top view of *PP* at $4^T$. Horizontal and vertical projection lines, respectively from these piercing points, will give $4^P$. The perspective of this frame, thus obtained, will be a *full* view of the frame, since the frame lies in *PP*. Perspectives of the frames behind *PP* can be obtained by the same method. Since 4 is also in a horizontal stiffener, a line from $4^P$ to *VP* will represent the perspective of this horizontal stiffener.
3. Draw the circle of vision and complete the perspective.

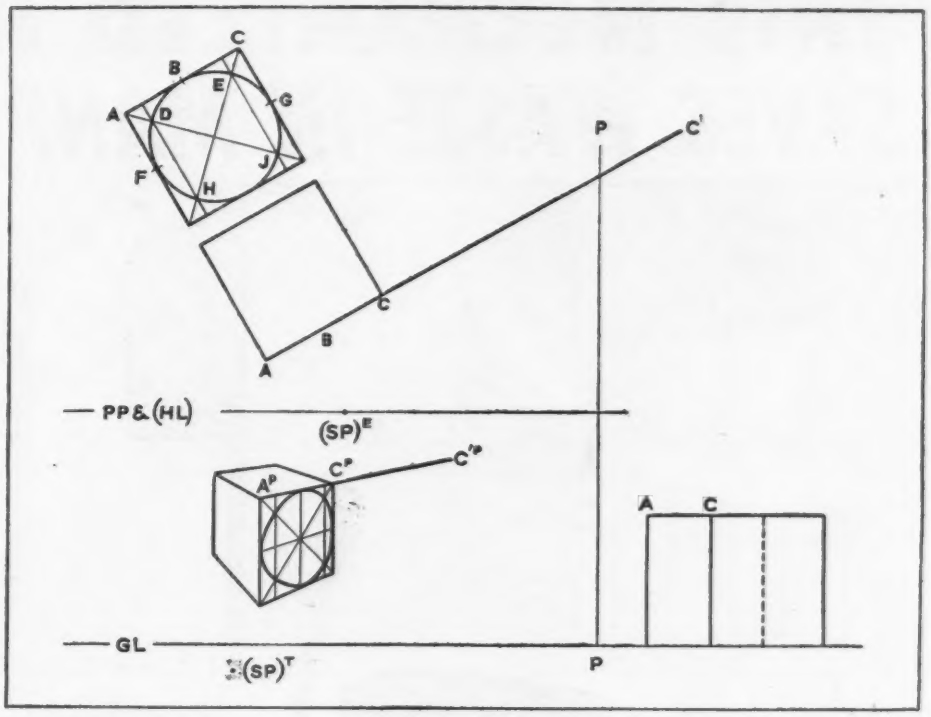


**Fig. 21. Expedients.** Diagonal method for determining circle in perspective, also a more accurate means for determination of the VP by Method 1.

In making perspectives, the use of certain simple constructions and approximations will be found time-saving. Perhaps the most important of these expedients is the construction of a perspective scale on a paperstraight-edge for horizontal and vertical lines which repeatedly are divided into the same number of proportionate parts.

For example, again referring to Fig. 11 (page 151, Mar. AVIATION) it may be necessary to divide the horizontal lines

(*Turn to page* 375)

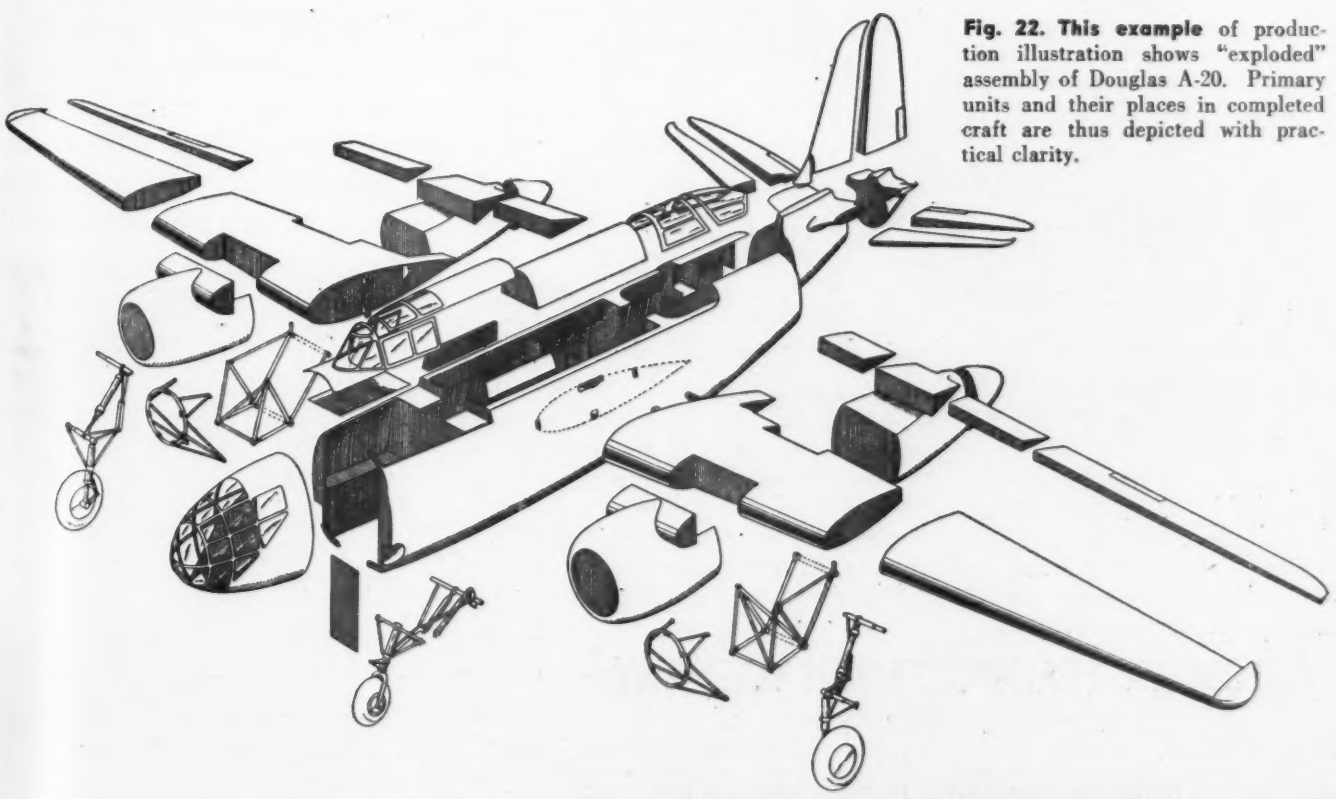

**Fig. 22. This example** of production illustration shows "exploded" assembly of Douglas A-20. Primary units and their places in completed craft are thus depicted with practical clarity.

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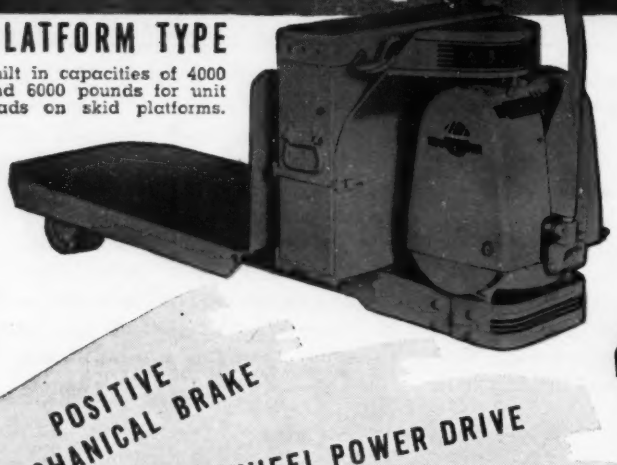

## PALLET TYPE

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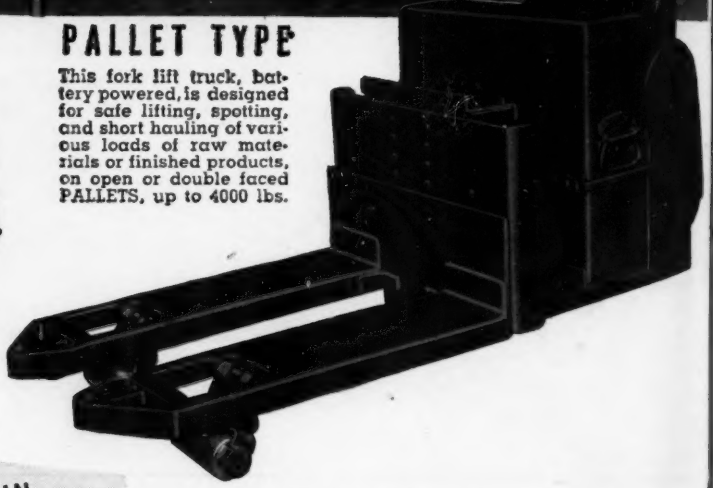

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# Production Speeded On Welded Seam Inlet Elbows

**How Buick makes new-type inlet elbows for P & W engines, replacing seamless-tubing units formerly employed on power plants.**

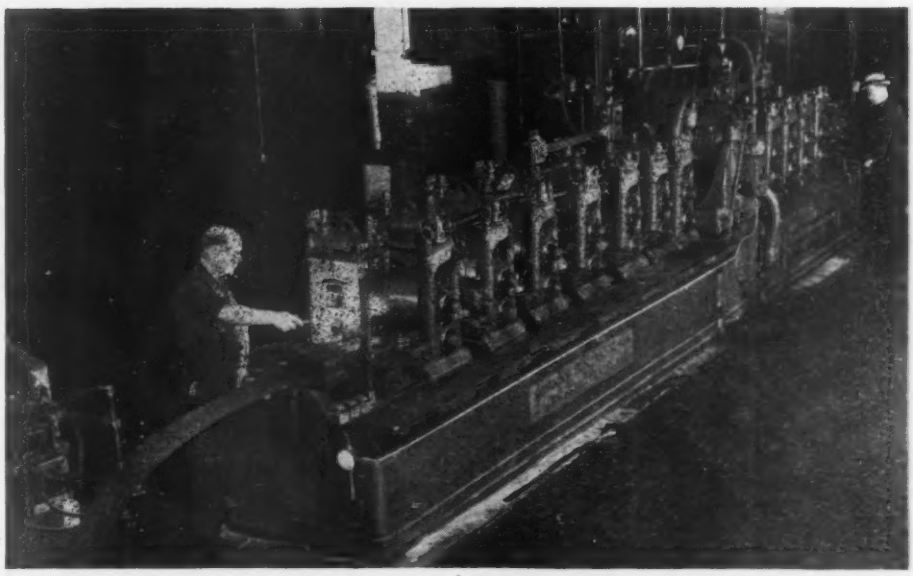
CRITICAL SHORTAGES of seamless steel tubing have, in recent months, led to the substitution of welded seam tubing for many aircraft parts. Reports indicate that welded tubing, when properly made and correctly applied, gives entirely satisfactory service.

Inlet elbows for Pratt & Whitney engines, as built by three different manufacturers, have now been added to the growing list of successful applications of welded tube. In this case, Buick produces the tubing in a machine formerly employed for making torque tubes for passenger cars, and this firm is also caring for its own needs as well as for those of both other makers. In addition to making the tubing itself, the company also cuts it to length, forms it into elbows, sizes it in an unusual way, and sandblasts and paints it prior to shipment to engine assembly plants.

The intake elbows are of 2⅜-in. dia. and are furnished in 16- and 18-in. lengths, the shorter serving the rear bank of engine cylinders and the longer the front bank. In all, 14 elbows per engine are required. Each elbow makes a right-angle bend which has to be smooth and free of wrinkles.

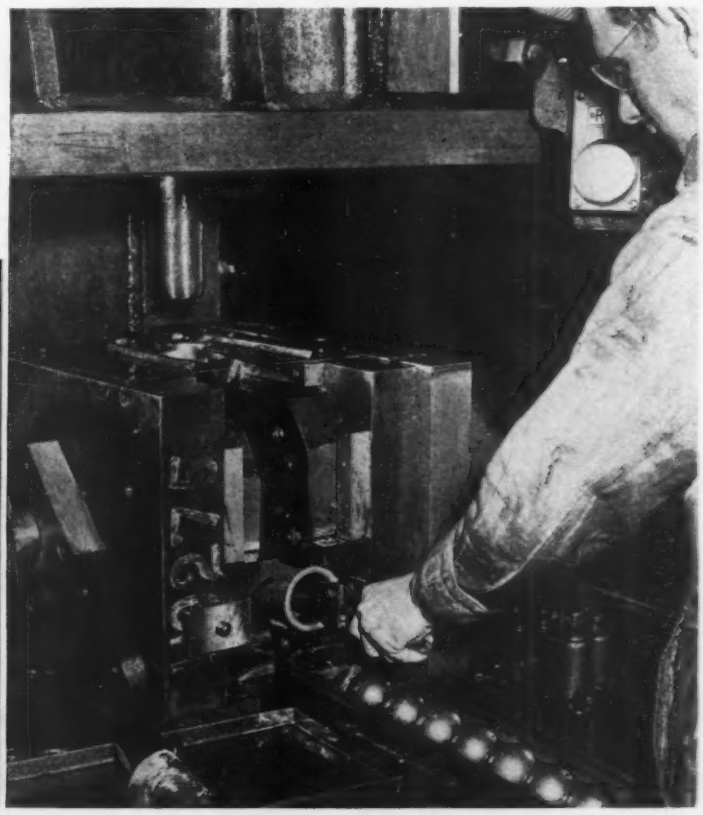
Both forming and welding of the tubing are done in a special machine built by the American Electric Fusion Corp. Initially, SAE 1010 strip steel is fed in from a coil at one end. Forming is accomplished by a series of seven pairs of rolls through which the strip passes. Then the formed tube is fed between a pair of automatic welding rolls which produce a continuous resistance weld. Flash is formed outside the

(*Turn to page* 393)



**Machine employed by Buick** for continuous automatic seam welding of tubing. Rolls seen in foreground form the tubing from strip stock. Beyond first seven pairs of forming rolls is pair of welding rolls and four pairs of sizing rolls.

**After lengths of tubing** have been bent into elbows, latter are placed in hydraulically operated die on bed of this press, and a ram and six chaser balls are used to force a sizing ball through elbow, at same time removing any wrinkles.



**When forming is completed** and flange has been sheared off, tubes are set in holders on this conveyor, which carries them through an automatic sandblast to clean interior and prepare exterior for painting.

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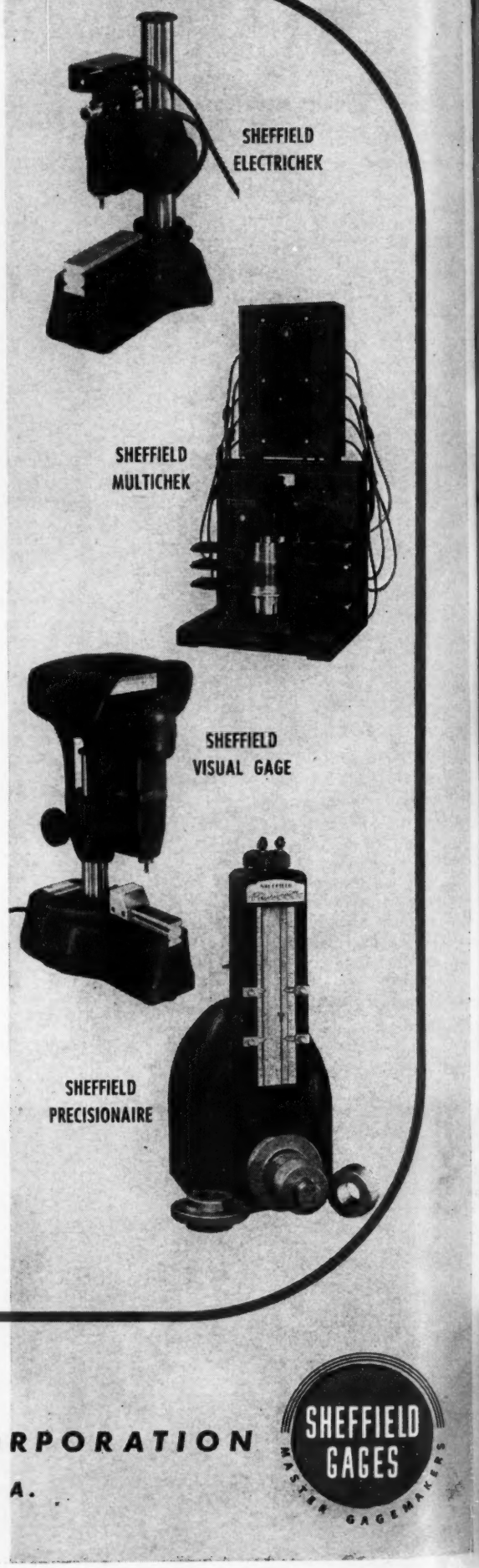


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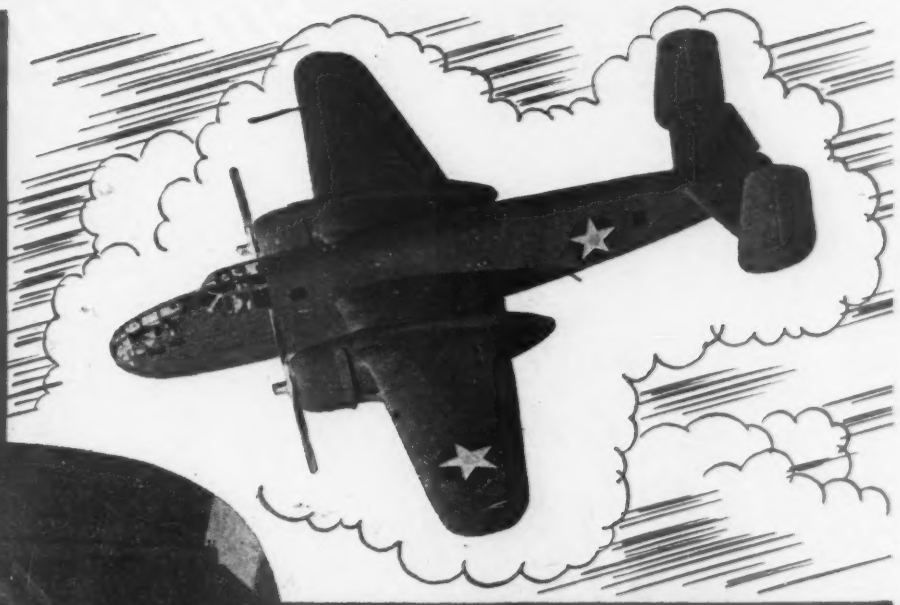

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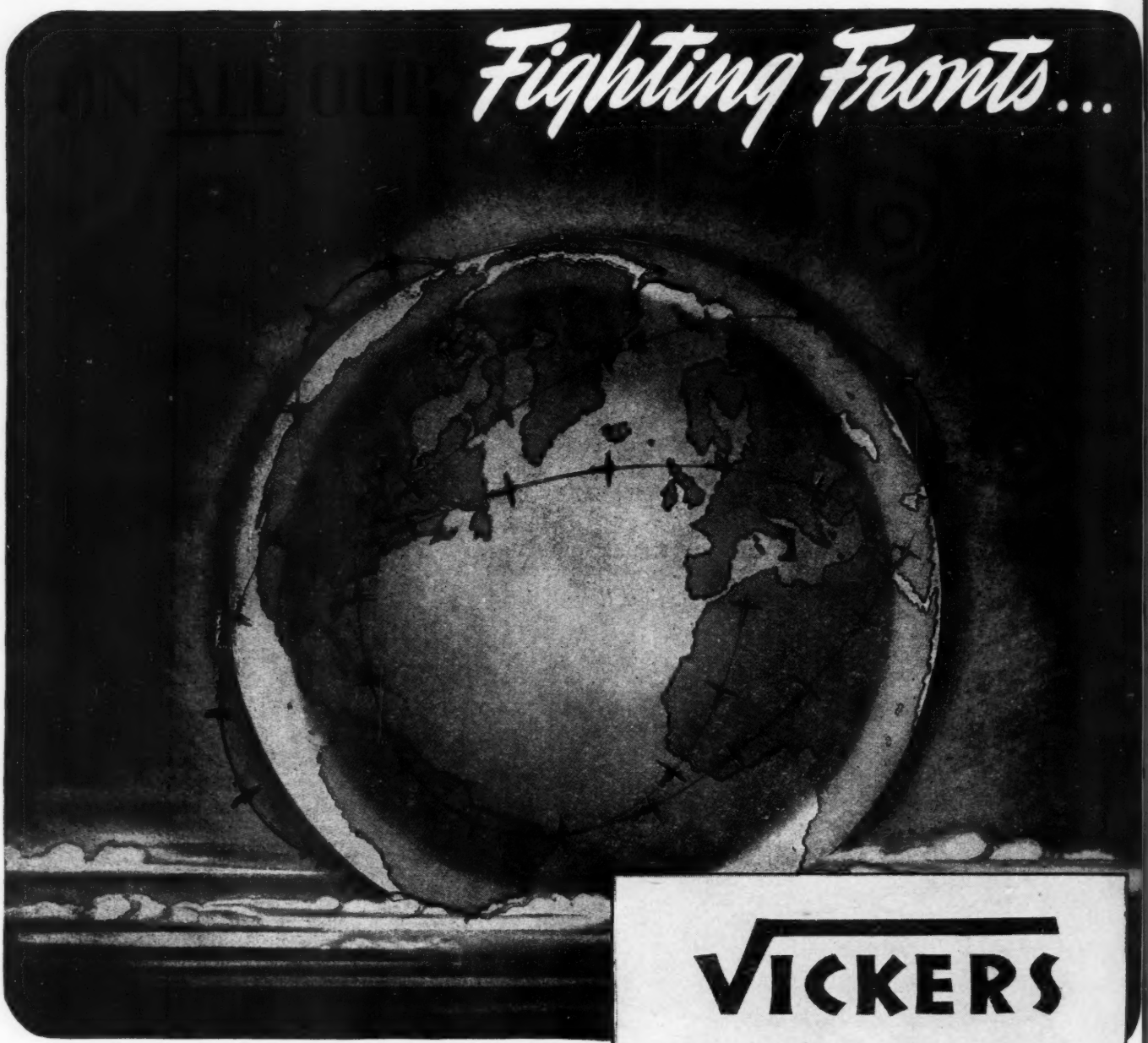


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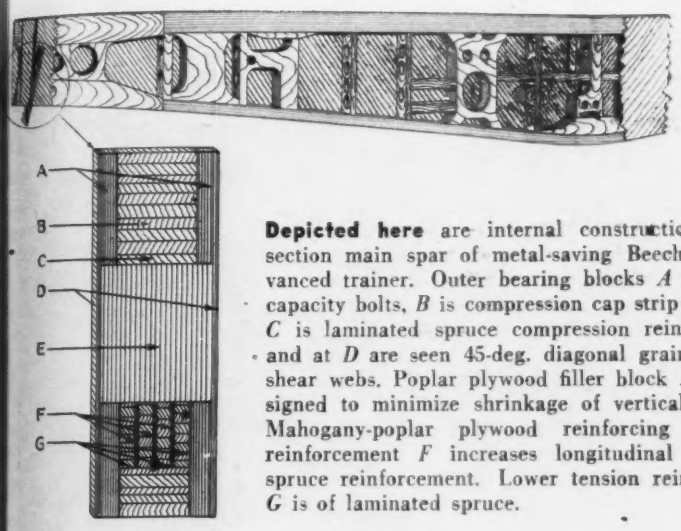
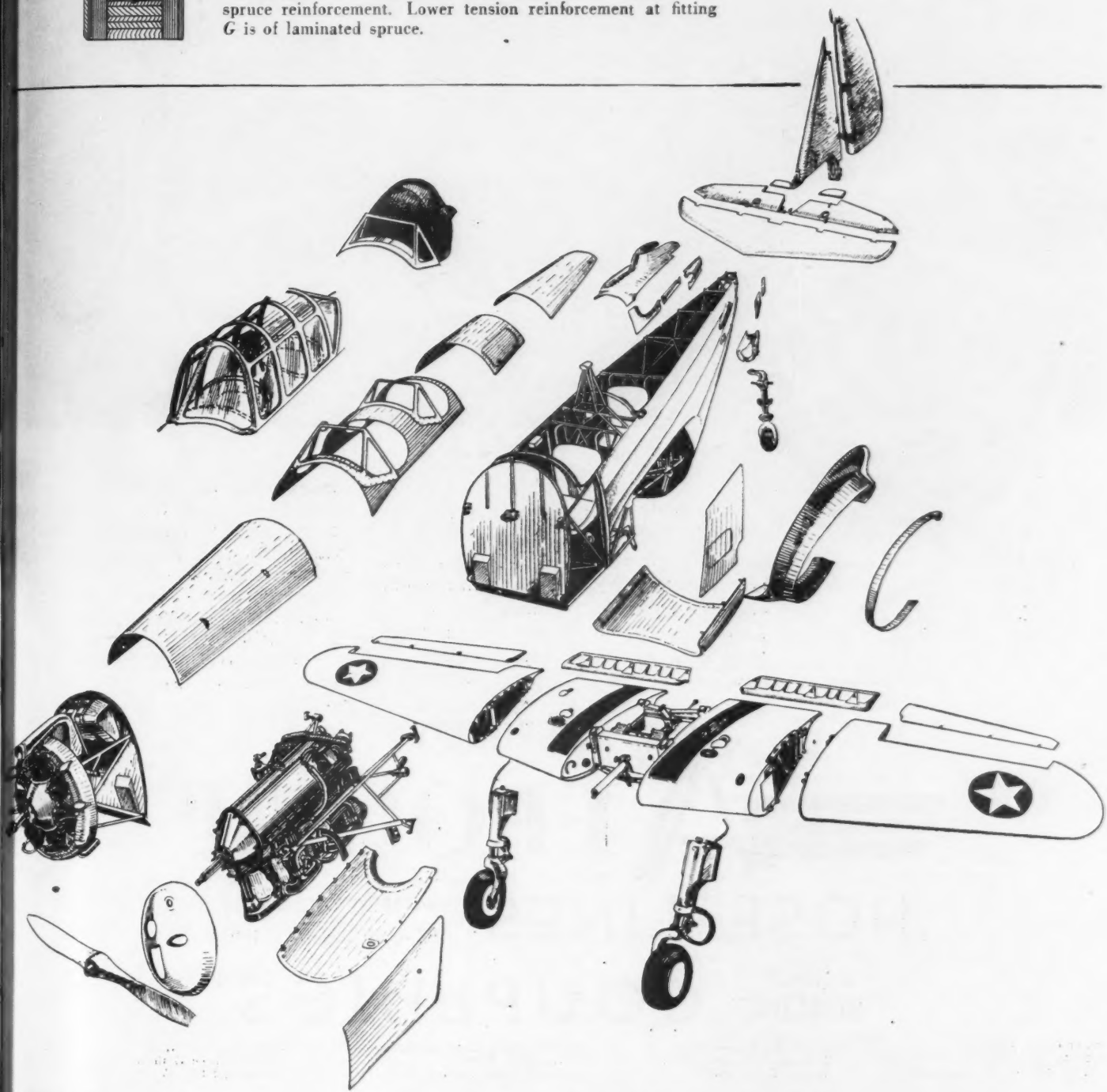



**Depicted here** are internal construction details of center section main spar of metal-saving Beech AT-10 *Wichita* advanced trainer. Outer bearing blocks *A* are for high bearing capacity bolts, *B* is compression cap strip of laminated spruce, *C* is laminated spruce compression reinforcement at fitting, and at *D* are seen 45-deg. diagonal grain mahogany plywood shear webs. Poplar plywood filler block *E* construction is designed to minimize shrinkage of vertical dimension of spar. Mahogany-poplar plywood reinforcing for lower tension reinforcement *F* increases longitudinal shear resistance of spruce reinforcement. Lower tension reinforcement at fitting *G* is of laminated spruce.

## SKETCH BOOK OF DESIGN DETAIL



**This exploded view** shows assembly components of both Fairchild PT-19 and PT-26 *Cornell* version of this widely used primary trainer. Principal differences are that PT-19 is powered by 175-hp. Ranger 6 inline aircooled engine and has open cockpits, while PT-26 version utilizes 200-hp. Ranger engine and has enclosed cockpit. Craft has also been designed to accommodate seven-cylinder radial aircooled Warner engine. Both PT-19 and PT-26 are 36-ft. span ships.

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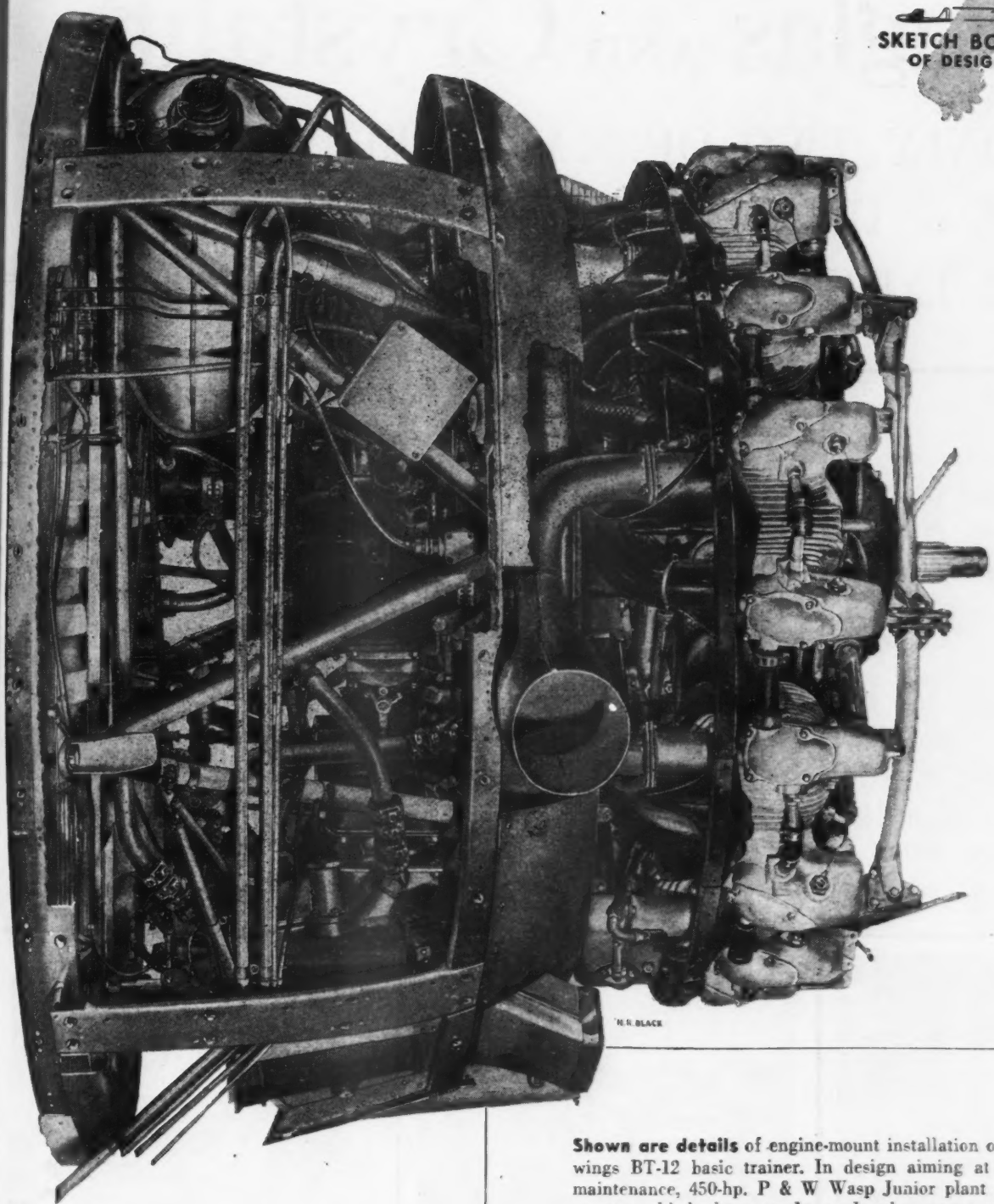

**Shown are details** of engine-mount installation on Fleetwings BT-12 basic trainer. In design aiming at ease of maintenance, 450-hp. P & W Wasp Junior plant is fitted on arc-welded chrome-moly steel tube mount which is bolted to stainless steel firewall with four tension bolts. Oil tank and all accessories are attached to engine and mount so removal of complete power plant unit is possible by disconnecting minimum of lines and removal of tension bolts. There is ready access to entire accessory compartment via four pieces of cowling held on with quick-acting shake-proof fasteners. Square-type air filter, in air mixing chamber casting, is readily removable for cleaning through door in rear of casting. Oil tank comprises two aluminum halves gas-welded together. Collector well and shroud are of annealed stainless steel. Ring cowl, supported by three shear-type rubber shock mounts, has carburetor air duct, oil cooler duct, and accessory compartment cooling duct incorporated within.

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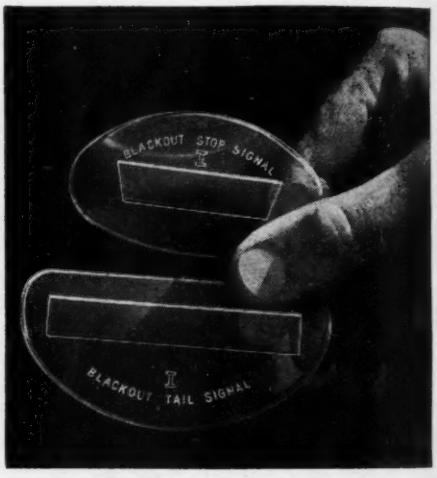


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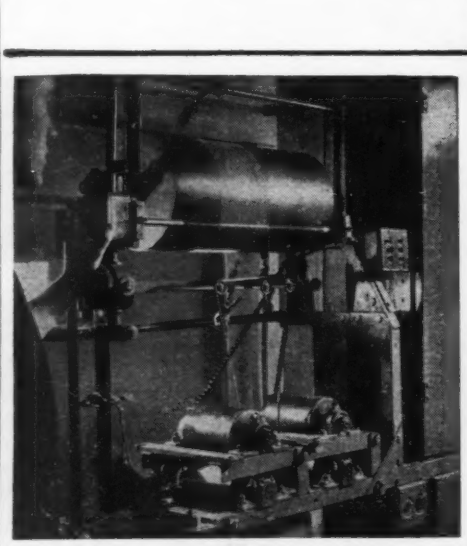
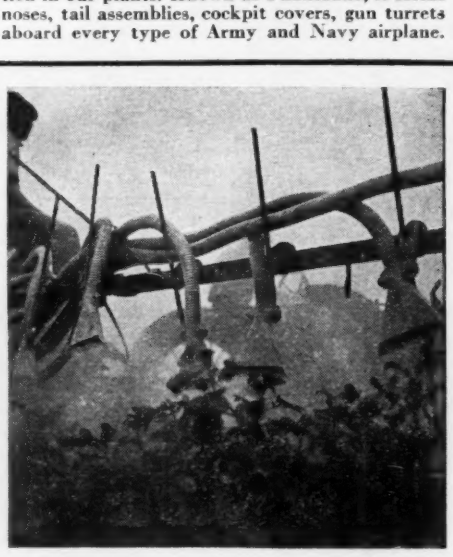


**MODERN FAST TEXTILE COLORS** presented a need for reducing agents. Rohm & Haas LYKOPON was the first to fill this need. Among our many other developments are RHONITE finishes that make fabrics "crushproof". This yarn slasher is typical of equipment in our textile laboratories which permits close approximation of mill results.



**LETHANE 60 WAS DEVELOPED** for use in agricultural dusts and sprays. Wide commercial use of this synthetic insecticide has demonstrated that replacing 50% of the rotenone or pyrethrum in dusts and sprays with LETHANE 60 not only stretches this country's limited supplies of botanical toxicants, but actually makes better products.

**THE ROHM & HAAS COMPANY** developed the first synthetic bate for leather. Today, this bate, under the name OROPON, is in common use in every country of the world. Later developments include synthetic tanning materials to produce great amounts of high quality white leather and finishes producing flexible and washable leathers.

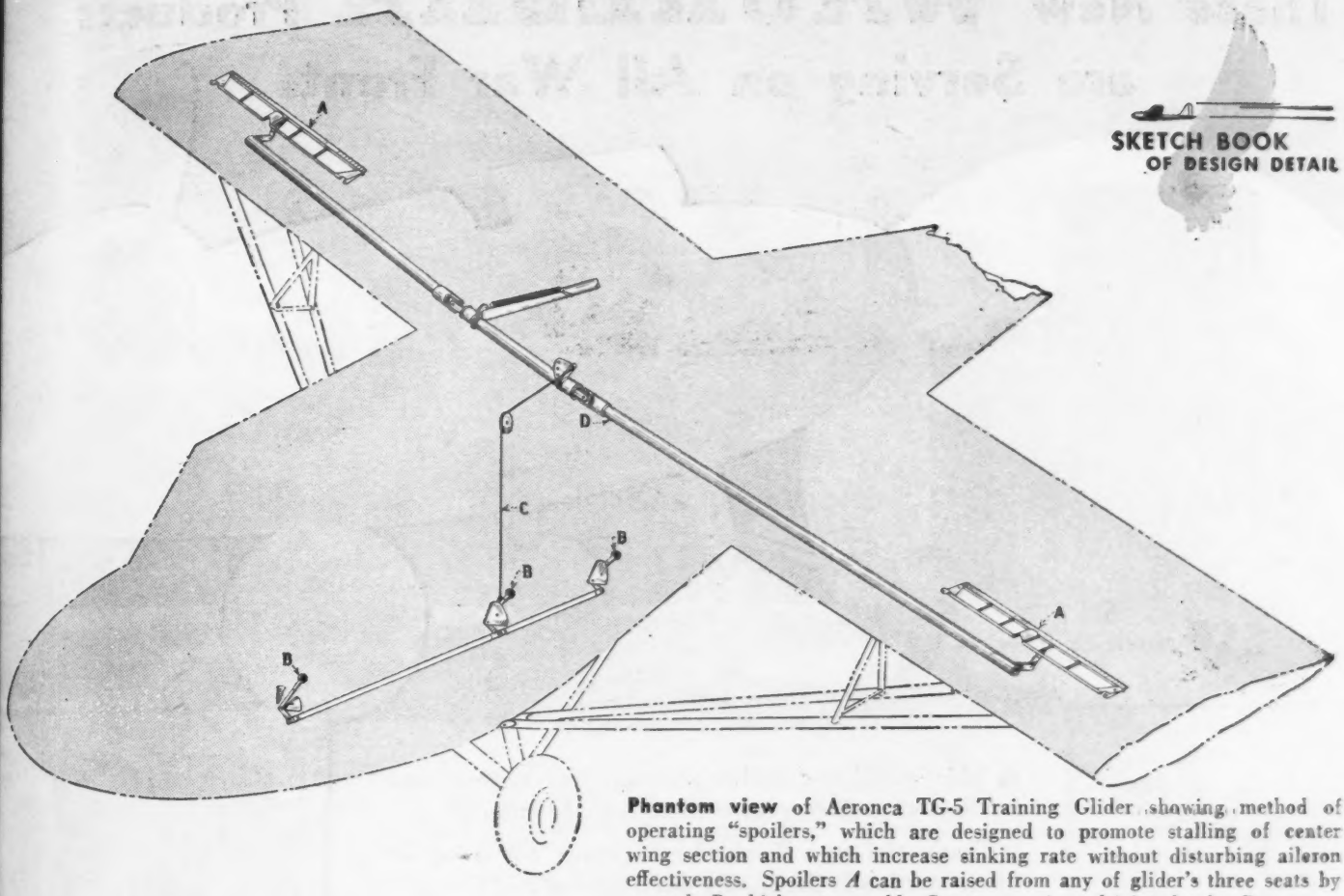
PLEXIGLAS, CRYSTALITE, LYKOPON, RHONITE, LETHANE and OROPON *are trade-marks, Reg. U. S. Pat. Off.*

# ROHM & HAAS COMPANY

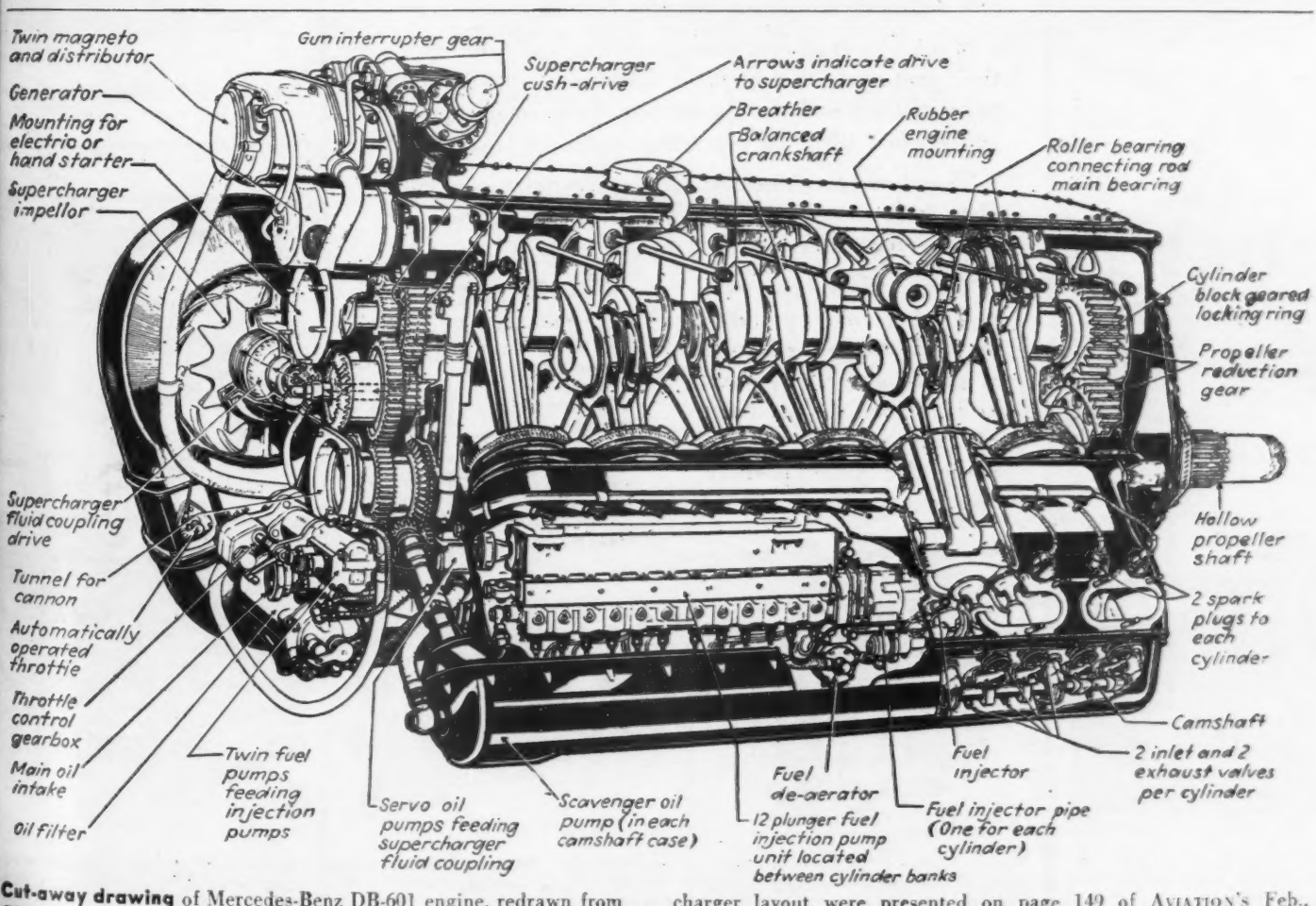
WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Chemicals including Plastics . . Synthetic Insecticides . . Fungicides . . Enzymes . . Chemicals for the Leather, Textile and other Industries

## SKETCH BOOK OF DESIGN DETAIL

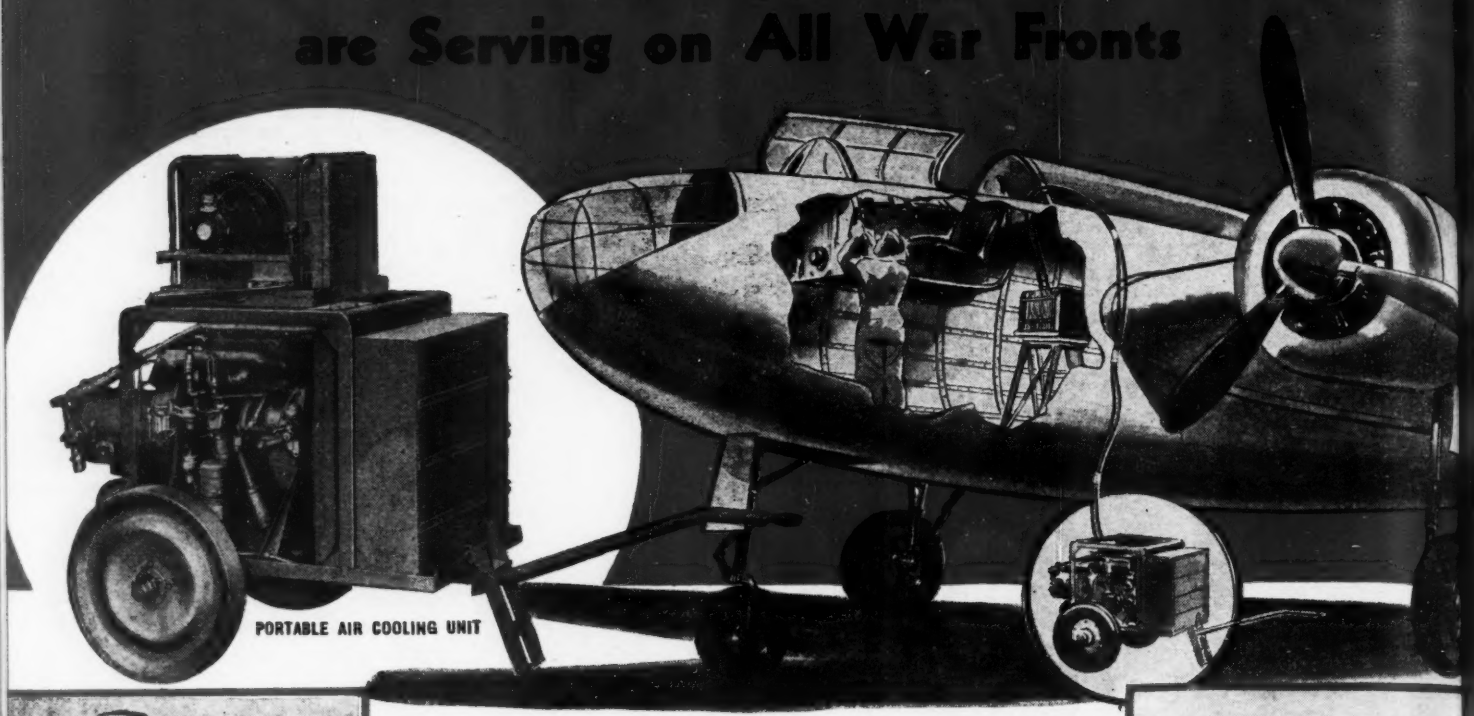


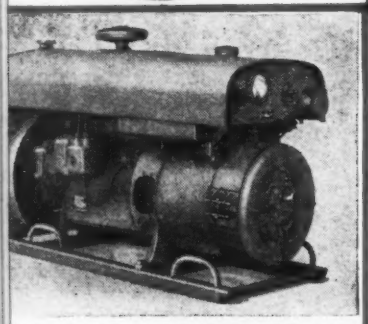

**Phantom view** of Aeronca TG-5 Training Glider showing method of operating "spoilers," which are designed to promote stalling of center wing section and which increase sinking rate without disturbing aileron effectiveness. Spoilers *A* can be raised from any of glider's three seats by controls *B* which act on cable *C* to turn universal-jointed tube *D*.


Twin magneto and distributor
Gun interrupter gear
Supercharger cush-drive
Arrows indicate drive to supercharger
Generator
Mounting for electric or hand starter
Supercharger impellor
Breather
Balanced crankshaft
Rubber engine mounting
Roller bearing connecting rod main bearing
Cylinder block geared locking ring
Propeller reduction gear
Supercharger fluid coupling drive
Tunnel for cannon
Automatically operated throttle
Throttle control gearbox
Main oil intake
Oil filter
Twin fuel pumps feeding injection pumps
Servo oil pumps feeding supercharger fluid coupling
Scavenger oil pump (in each camshaft case)
Fuel de-aerator
12 plunger fuel injection pump unit located between cylinder banks
Fuel injector
Fuel injector pipe (One for each cylinder)
Hollow propeller shaft
2 spark plugs to each cylinder
Camshaft
2 inlet and 2 exhaust valves per cylinder

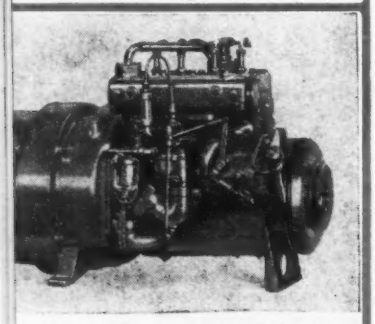
**Cut-away drawing** of Mercedes-Benz DB-601 engine, redrawn from *Flight*, shows main structural characteristics of one of Luftwaffe's most widely used power plants. Details of crankcase and supercharger layout were presented on page 149 of AVIATION's Feb., 1942, Sketch Book. For installation in Messerschmitt 109 see pages 169-171 of Mar., 1942, number.

# These New WAUKESHA Products are Serving on All War Fronts



ightweight, 5-KVA, 4-KW, 60-ycle, single-phase, 115-volt, di-ect-connected Engine Generator.



-10-KW, 28.5-volt, DC, Engine enerator, direct connected, for arine use.

litz Starter—an auxiliary en-ine and power unit heater for rctic operation.

★ This is a highly mechanized war. Its many new and unheard-of problems have to be solved—*quickly!*

That's the way Waukesha engineers are doing it. Their war job is the speedy development and fast production of highly mobile, lightweight, completely portable engine-operated equipment—for use on all fronts.

Waukesha engineers were given this war job because their past experience inspired confidence in their ability to do it. They had already developed similar products—and applied them to peacetime purposes *successfully*.

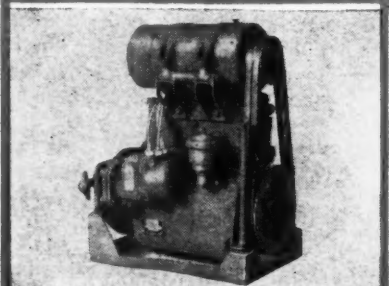
They have the imagination, the ingenuity, *and* complete facilities. They have put them *all* to work—to produce for victory.

Peace, when it comes, will bring more progress in production—for *service is continuous* with Waukesha. *Then* the products of that service will be ready for *your* postwar uses.

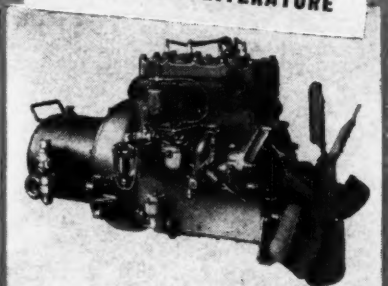
**ALL THESE UNITS**

- Available with pneumatic or steel wheels. Also skid mounted.
- Extremely light weight for air-borne delivery.
- Operate satisfactorily on aviation or commercial gasolines.

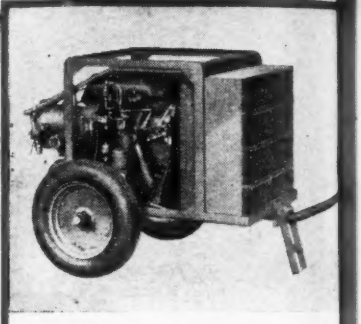
**WRITE FOR LITERATURE**



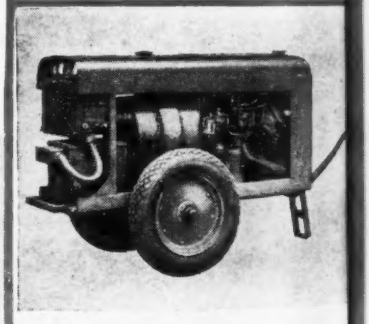
Lightweight Power Unit for operating 4-KW ordnance-type generators.



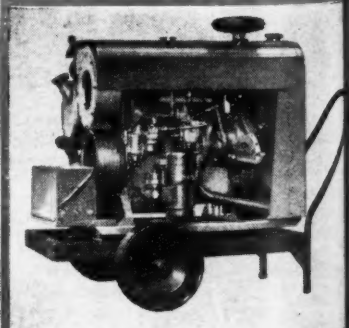
Lightweight Engine Compressor (refrigeration) Unit; 2, 3 and 4-ton capacity.



Portable Refrigeration and Air cooling Unit.



5–10-KW, 28.5-volt, DC, Engine Generator, direct connected.



Lightweight Power Unit for operating 5–10-KW aircraft-type generators.

REFRIGERATION DIVISION

ept. V, WAUKESHA MOTOR COMPANY, Waukesha, Wisconsin

Largest Builders of Mobile Engine-Driven Refrigeration and Generator Equipment

# Cold Bonding Tests

## Varying Conditions and Materials

**TABLE I—Study of Double Spreading**

Plywood and Block Shear Breaks and Percent Wood Failure[1]

| | | | | | | |
|---|---|---|---|---|---|---|
| Plywood Shear Tests—dry | 400— 0 | 380— 10 | 330— 30 | 380— 10 | 310— 20 | 300— 90 |
| | 330— 0 | 410— 10 | 340— 10 | 360— 50 | 340— 10 | 410— 50 |
| | 380— 0 | 420— 10 | 400— 30 | 380— 40 | 340— 0 | 360— 20 |
| | 380— 10 | 340— 20 | 410—100 | 370— 20 | 310— 10 | 360— 0 |
| | 410—100 | 400— 10 | 400— 90 | 350— 10 | 290— 0 | 360— 0 |
| Averages (lb./sq. in.) | 380— 22 | 390— 12 | 376— 52 | 368— 26 | 318— 8 | 358— 32 |
| Plywood Shear Tests—wet—48-hr. | 320— 20 | 350— 10 | 340— 0 | 300— 0 | 280— 0 | 340— 40 |
| | 290— 10 | 340— 0 | 360— 30 | 380— 30 | 300— 0 | 370— 10 |
| | 340— 10 | 300— 0 | 340— 10 | 360— 0 | 300— 0 | 300— 0 |
| | 310— 0 | 300— 0 | 350— 10 | 310— 0 | 240— 0 | 280— 0 |
| | 370— 20 | 300— 10 | 320— 0 | 300— 0 | 310— 0 | 290— 0 |
| Averages (lb./sq. in.) | 326— 12 | 318— 4 | 342— 18 | 330— 6 | 286— 0 | 316— 10 |

Grand Average, DRY TEST, 365—25, specification AN-G-8, 340
Grand Average, WET TEST, 319— 8, specification AN-G-8, 280

| | | | | | |
|---|---|---|---|---|---|
| Block Shear Tests—dry | 7,670— 90 | 9,840—100 | Gross average, 3 sq. in. | 8,670— 90 | 9,906— 94 |
| | 8,710— 90 | 9,540—100 | Net average, 1 sq. in. | 2,890 | 3,302 |
| | 8,490—100 | 10,200—100 | Specifications | 2,800 | 2,800 |
| | 6,820— 60 | 9,790— 70 | | | |
| | 8,810— 80 | 10,160—100 | | | |

CONDITIONS

*Spread:* Uformite CB-551 applied on both faces in every joint; each face spread at rate of 20-lb. liquid mixture per 1,000 sq. ft. Total spread per glue line—40 lb. per 1,000 sq. ft.
*Solids content:* 71.3 percent.
*Assembly time:* Closed, 5 to 12 min.
*Veneers:* 1/16-in. birch, 7 percent moisture content, standard 3-ply construction, with center layer crossed.
*Blocks:* 3/4-in. hard maple lumber, 7 percent moisture content, laid parallel.
*Pressure:* Hand clamps, estimated at 100 lb., 16 hr. at 75 deg. F.
*Aging:* Six days at 75 deg. F. before testing in the Riehle machine.

**TABLE II—Study of Single Spreading**

Plywood and Block Shear Breaks and Percent Wood Failure[1]

| | | | | | |
|---|---|---|---|---|---|
| Plywood Shear Tests—dry | 330— 60 | 400—100 | 430— 10 | 450— 90 | 390— 80 |
| | 400— 70 | 400— 70 | 370— 10 | 420— 90 | 390— 70 |
| | 350— 30 | 410— 40 | 360— 40 | 390— 60 | 430— 90 |
| | 390— 20 | 330— 20 | 400— 50 | 310— 10 | 430— 80 |
| | 350— 0 | 360— 10 | 420— 20 | 390— 40 | 420— 80 |
| Averages, 1 sq. in. | 364— 36 | 380— 48 | 396— 26 | 392— 58 | 412— 80 |
| Plywood Shear Tests—wet—48-hr. | 290— 0 | 310— 0 | 330— 0 | 330— 80 | 310— 0 |
| | 270— 0 | 280— 0 | 290— 0 | 390— 50 | 340— 0 |
| | 320— 0 | 250— 0 | 290— 0 | 370— 0 | 390— 80 |
| | 250— 0 | 290— 0 | 280— 0 | 370— 10 | 400— 80 |
| | 290— 0 | 250— 0 | 250— 0 | 310— 0 | 300— 0 |
| Averages, 1 sq. in. | 284— 0 | 276— 0 | 284— 0 | 364— 28 | 384— 32 |

Grand Average, DRY TEST, 389—49, specification AN-G-8, 340
Grand Average, WET TEST, 308—12, specification AN-G-8, 280

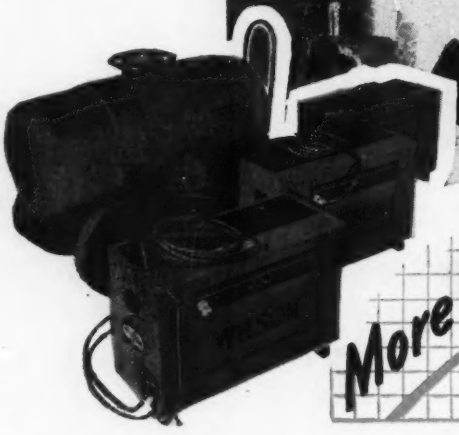
| | | |
|---|---|---|
| Block Shear Tests—dry | 8,140—100 | 8,420—100 |
| | 8,690—100 | 8,120—100 |
| | 8,000—100 | 7,870— 80 |
| | 8,350— 70 | 8,620— 90 |
| | 8,320— 90 | 8,370— 90 |
| Gross average, 3 sq. in. | 8,690— 92 | 8,520— 92 |
| Net average, 1 sq. in. | 2,897 | 2,840 |
| Specifications | 2,800 | 2,800 |

[1] In above tables, first figure of each pair represents shear value in lb./sq. in. (per 3 sq. in. on blocks), and second figure is percentage of wood failure.

CONDITIONS

*Spread:* Uformite CB-551 applied on one face in each joint at the rate of 44 to 55 lb. liquid mixture per 1,000 sq. ft. of glue line.
*Solids content:* 72.3 percent.
*Assembly, veneers, blocks, pressure, and aging:* Same as in Table I.

(Continued on next page)



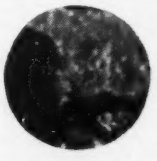
# More Welding-Better Quality Welds with the "WILSON HONEY BEE" ARC CONTROL STATION

TWO or more "Honey Bees," connected to any constant potential arc welding generator, increases the number of welding arcs that can operate simultaneously from a single welding machine.

At the same time the "Honey Bee" assures better welds on light gauge metal – thanks to Wilson Remote Crater Control. Craters, porosity and similar defective welds are prevented because Crater Control permits the operator to fade out the arc slowly – never breaking it abruptly.

Each operator using a "Honey Bee" station has full control over his welding current. A switch conveniently held in the operator's hand enables him to regulate his current while welding to any value (from zero to maximum) within the full range of the "Honey Bee" station. Changes in current setting do not affect the performance of any other "Honey Bee" stations working from the same generator.

The Wilson "Honey Bee" is available in two sizes – 75 amps. and 150 amps. For complete details get in touch with your nearest Air Reduction sales office. A descriptive bulletin ADW-47 will be forwarded on request.



Metal deposited with standard welding machine and no crater control.

Metal deposited with Wilson "Hornet" equipped with "Honey Bee" Remote Arc and Crater Control Station.

Photo courtesy of Curtiss-Wright Corporation.

WILSON

## WILSON WELDER and METALS CO., INC.

General Offices: 60 East 42nd Street, New York, N. Y.

# Cold Bonding Tests

**Varying Specific Pressure:**

Specific pressure is psi. on adhesive joint as against pressure over whole area. With soft woods, this question must be answered: How far can pressure be reduced without sacrificing quality of bond? Results under drastic reductions are surprisingly good in some cases.

Assembly time is elapsed time after spreading adhesive, before pressure application, and may be either with joints open or closed.

Further studies on effects of dyestuffs have been made, and they show effects to be negligible.

**TABLE III — Study of Quality of Bond under Three Variables—Wood Species, Pressure, and Assembly Time**

| Species Combined | Pressure Lb./sq. in. | Assembly Time | | | |
|---|---|---|---|---|---|
| | | 1 min. | 5 min. | 15 min. | 25 min. |
| | | Percent Wood Failure and Quality of Bond[1] | | | |
| Fir to fir | 1/3 | 10—G | 20—P | 20—G | 30—G |
| | 20 | 50—VG | 90—Ex | 60—VG | 90—Ex |
| | 60 | 100—Ex | 100—Ex | 80—Ex | 100—Ex |
| | 200 | 100—Ex | 100—Ex | 40—G | 100—Ex |
| Fir to birch<br>Failures in fir except as indicated | 1/3 | 10—F* | 0—F | 5—P* | 100—Ex |
| | 20 | 10—G* | 30—G | 50—VG | 30—G* |
| | 60 | 50—Ex† | 5—G* | 20—G* | 5—F |
| | 200 | 24—G† | 25—G† | 10—G* | 20—G |
| Fir to poplar<br>Failures all in fir | 1/3 | 50—VG | 50—G | 50—VG | 50—VG |
| | 20 | 100—Ex | 100—Ex | 95—Ex | 90—Ex |
| | 60 | 100—Ex | 100—Ex | 100—Ex | 100—Ex |
| | 200 | 100—Ex | 100—Ex | 100—Ex | 100—Ex |
| Poplar to poplar | 1/3 | 100—VG | 30—G | 80—VG | 50—VG |
| | 20 | 100—Ex | 100—Ex | 90—Ex | 100—Ex |
| | 60 | 100—Ex | 100—Ex | 100—Ex | 100—Ex |
| | 200 | 100—VG | 100—Ex | 100—Ex | 100—Ex |
| Poplar to birch<br>Failures all in poplar | 1/3 | 40—VG | 100—Ex | 80—VG | 5—G |
| | 20 | 70—VG | 100—Ex | 75—G | 40—P |
| | 60 | 30—F | 40—G | 100—Ex | 90—Ex |
| | 200 | 100—Ex | 100—Ex | 100—Ex | 100—Ex |
| Birch to birch | 1/3 | 50—Ex | 15—VG | 5—G | 60—VG |
| | 20 | 20—G | 50—Ex | 5—F | 10—F |
| | 60 | 0—F | 10—F | 100—Ex | 50—VG |
| | 200 | 0—G | 80—Ex | 15—G | 50—VG |

*Failure in birch
†Failure in both species

Ex = Excellent
VG = Very Good
G = Good
F = Fair
P = Poor

[1]A similar series of tests was run, using a 73 percent solids concentration without dyestuffs. Results agreed very closely with the above, without significant differences.

CONDITIONS

*Solids content:* 70 percent containing dyestuffs.
*Results:* Based on knife tests and estimated percentage of wood failure.
*Pressure:* Exerted by dead weight (50 lb. over 144 sq. ins. = 1/3 per sq. in.); by clamps (20 lb. and 60 lb.); and hydraulic (200 lbs.) maintained by clamps.

*Data Courtesy of Resinous Products & Chemical Co.*

# Review of Patents

By A. HARRY CROWELL,

*Registered Patent Lawyer*

FOLLOWING are digests of some of the more significant patents on recent aviation developments granted by the U. S. Patent Office. Mr. Crowell will be glad to furnish readers information without charge or obligation on approximate cost and procedure in applying for patents and trademark registrations. Address inquiries to him, care AVIATION, 330 W. 42nd Street, New York City. Printed copies of any of the patents listed below are obtainable at 10c. each from the Patent Office.

**Variable Pitch Airscrew** is designed as improvement in fluid transmission circuits of variable pitch propellers. Various oil circuits can be arranged independently of one another within propeller shaft, and replacement of one type of propeller by another can be effected with little alteration of internal arrangement of propeller shaft.—2,307,578, A. H. R. Fedden, assignor to The Bristol Aeroplane Co., Ltd.

**Gun Mount** has been designed so that muzzle of weapon need project but little, if at all outside surface of aircraft skin. Complete mounting and closure about gun can be readily sealed, and the invention is designed to reduce drag to a minimum. —2,307,582, J. F. Haberlin, assignor to Boeing Aircraft Co.

**Means for Indicating Turning Movements** is provided in instrument to aid blind flying. Pilot can, at all times, maintain complete control of ship whether or not fixed objects outside plane are visible. Indicating means, provided on face of instrument, is normally stationary until turning movement occurs.—2,307,590, T. W. Kenyon, assignor to Sperry Gyroscope Co.

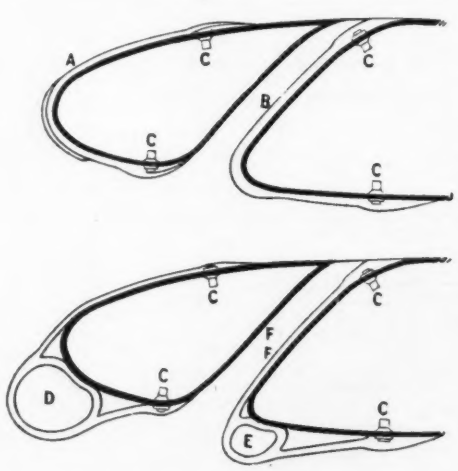
**Propeller With Adjustable Pitch** during flight. Anyone of a number of fixed pitches, it is claimed, can be obtained at will. In addition, if desired, an infinite series of pitches between two fixed extreme propulsion pitches are possible as well as a number of auxiliary pitches capable of being used under special operating conditions.—2,308,228, R. Matteucci, vested in Alien Property Custodian.

**Automatic Radio Direction Indicator.** This device has 360-deg. scale to give automatically accurate radio bearings substantially unaffected by mistuning, temperature or humidity changes, mechanical shocks, or signal or voltage variations. System employs a non-hunting, motor-driven, rotating loop antenna controlled by signal received.—2,308,521, W. P. Lear, assignor to Lear Avia, Inc.

**Machine Gun Mounts.** Here two patents are involved, with first intended to compensate for recoil when gun is fired at high angle of elevation. This consists of a spring and hydro-pneumatic damping cylinder. Second patent covers a mount for two guns which can be converted into a single mount in case one gun ceases to function. Thus sidewise kick, which results when one gun mounted to the side of the pivot is fired, is stated to be eliminated.—2,309,807 and 2,309,808, John C. Trotter, assignor to Bell Aircraft Corp.

**Landing Gear.** An improved telescopic shock absorber mounting for landing wheels to be used particularly where the structure of the plane necessitates positioning of the absorber axis obliquely forward, rearward, or laterally with respect to the vertical during taxiing.—2,308,573, filed Apr. 6, '40, issued Jan. 19, '43, P. W. Thornhill, assignor to Automotive Products Co., Ltd.

**Method for Simulating Bombing** uses a photographic means for simulating aircraft bombing for the training of personnel in bombing technique. The apparatus secures permanent records for checking the accuracy of the results and also enables the determination of the theoretical point of impact of an actual or imaginary bomb released from an aircraft.—2,310,613, filed Mar. 22, '38, issued Feb. 9, '43, A. Briechle, R. T. Hurley and G. E. Merritt, assignors to Bendix Aviation Corp.




**Inflatable rubber shoes,** designed to prevent accumulation of ice in vicinity of wing slots, increase rather than decrease lifting effect of wing, and reduce stalling speed, have been patented by Clifford T. Sears. Two separate shoes, "A" on leading edge of wing and "B" on rear wall of slot, are fastened into hollow rivets, "C," on skin surface. When shoes are inflated, bulbous distentions, "D" and "E," increase wing camber and extend opposite walls of slot, "F," downward, thus increasing effective slot passage and resulting lift-drag ratio.—2,306,759, assigned to the B. F. Goodrich Co.

**Composite Control Cable** modifies the effective coefficient of expansion of a flexible cable by swaging a tubular sheath over it. The resulting cable is said to be particularly advantageous to aircraft. —2,308,669, filed May 5, '39, issued Jan. 19, '43, C. F. Beed, assignor to Lockheed Aircraft Corp.

**Composite Airplane-Glider** with wings of the latter designed to increase lift of plane to which it is attached. When take-off is accomplished, glider pilot may detach his ship and bring it back to earth.—2,308,764, filed April 30, '40, issued Jan. 19, '43, V. S. Makaroff.

**Fighting Airplane** has guns, constructed in after part of fuselage, which can be fired rearward. Rear gunner is in a position to reduce the angle of incidence of the wing, which is swingable, by a control and thus independently increase velocity of the plane.—2,308,796, filed Sept. 7, '39, issued Jan. 19, '43, Claude Dornier, vested in Alien Property Custodian.

**Parachute Unit.** For retarding the opening of the parachute, an auxiliary canopy is arranged between the main canopy and the parachutist. The auxiliary acts as a screen preventing the main canopy from filling violently until the speed of descent has decreased to a predetermined limit.—2,308,797, filed Mar. 16, '40, issued Jan. 19, '43, P. Nasca, vested in Alien Property Custodian.

**Steering Mechanism** for aircraft landing gear, especially applicable to a retractable nose wheel swiveled to steer the plane on the ground, includes an oleo-gear type shock absorber assembly which acts both as a part of the wheel mounting and as a means to absorb part of the landing shock. The invention also includes a means to prevent shimmying as the plane is landed or taxied.—2,308,846, filed Sept. 11, '40, issued Jan. 19, '43, J. W. White, assignor to Bendix Aviation Corp.

**Aircraft Wing.** Structure of front and rear wing sections is simplified to insure quick and easy installation of fuel tanks, bomb releasing apparatus, etc. Permanent or movable tubular auxiliary supports are connected to the spar by brackets. Skin-supporting ribs are interconnected near the spar by sections extending along the longitudinal axis of the wing, and front and rear sections are fastened over auxiliary supports.—2,308,935, filed June 13, '40, issued Jan. 19, '43, E. Scheler, vested in Alien Property Custodian.

**Utility Cockpit Lamp Assembly.** The several separate lamps generally used in night flying are contained in a single assembly consisting of an easily adjustable lens and light shield to spread or concentrate the beam as desired.—2,309,104, filed May 2, '41, issued Jan. 26, '43, A. D. Dircksen and H. H. Tellman. May

(*Turn to page* 397)

ADDING BOMB RACKS TO A "TRAINER" DOES NOT MAKE A BOMBER

# Adding a Plow to a truck does not make a Snow Fighter

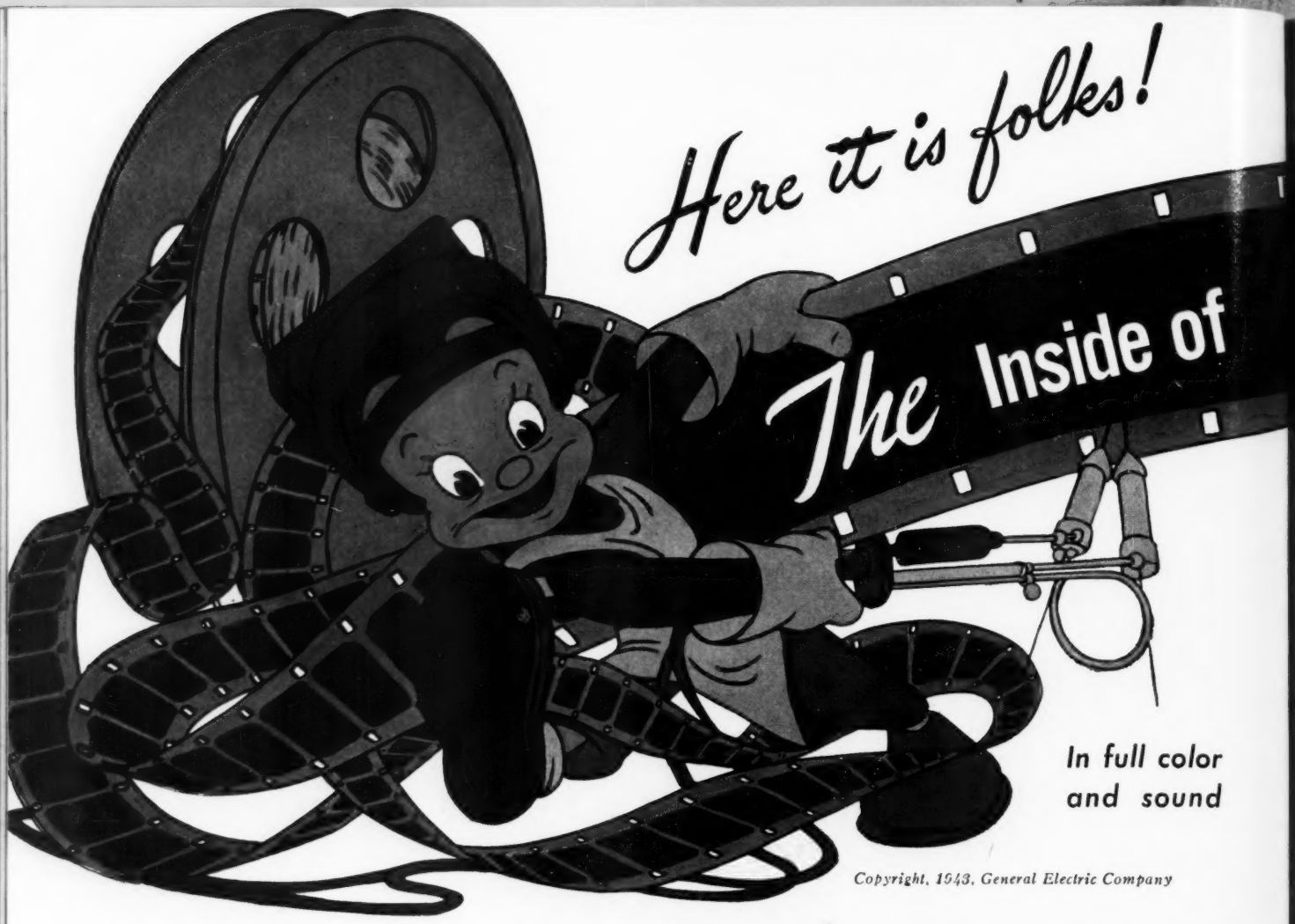
SNOW removal is a specialized, punishing job! Experience proves that the first requirement is a unit exclusively designed for the task. Standard heavy-duty hauling trucks are not built to withstand drift-bucking, lack the power and traction to push through heavy snows—therefore fall short of the job, no matter how you "dress them up" with auxiliary equipment.

Rugged, powerful Walter Snow Fighters are the product of 25 years' collaboration between Walter engineers and the best-informed snow removal experts. Walter Snow Fighters have many times the snow-clearing capacity of other units. They clear 16 foot widths, at average speeds over 10 m.p.h.—eliminate dangerous snow banks—meet every airport snow condition. Among the exclusive features are Walter 4-Point Positive Drive, with three automatic locking differentials; Suspended Double Reduction Drive; tractor type transmission and many others.

No time is "too early" to investigate methods for combating a foe as costly and dangerous as Snow. Write for literature giving full details.

**WALTER** FOUR POINT POSITIVE DRIVE **Snow Fighters**

**WALTER MOTOR TRUCK CO.**
1001-19 IRVING AVENUE
RIDGEWOOD, QUEENS, L. I., N. Y.

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## Another new super-colossal G-E training film

This *new* film shows in complete detail exactly what the atomic-hydrogen welding process is, how it is used, and what it is best suited to do.

Produced by the Raphael G. Wolff Studios, under the direction of the G-E welding laboratories, it follows the same pattern which proved so successful in "The Inside of Arc Welding."*

**MADE IN TWO PARTS**

(16 mm—each part 10 minutes)

PART ONE describes and illustrates the fundamentals of atomic-hydrogen welding. It shows how to regulate the welding current and the hydrogen supply; how to adjust the electrode holder and the tungsten electrodes; and how to recognize and correct improper adjustment.

PART TWO shows proper technique for making corner, edge, fillet and groove welds; how to control the molten pool; and how to make sure of proper penetration, good fusion, and uniformity. Particular emphasis is given these four factors—current setting, speed of travel, size of arc, and the contact of the arc with the work.

**More than 2400 reels of "The Inside of Arc Welding" are now in regular use.*

**YOU CAN BUY these films at print cost; that is, $52.00 per part, or—**
**YOU CAN BORROW prints for a single showing, without cost except for transportation.**

Simply contact your G-E arc-welding distributor or mail the coupon to the nearest address listed.

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570 Lexington Ave., New York City, N. Y.
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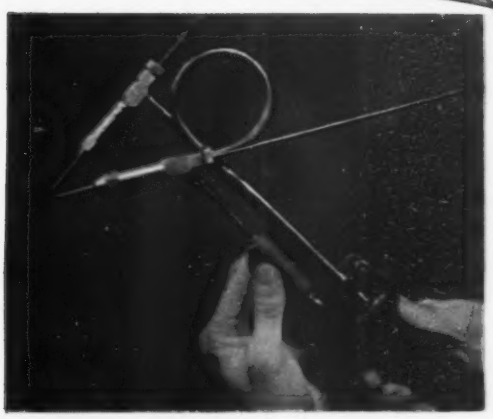
# ATOMIC-HYDROGEN ARC WELDING

SKILLED OPERATORS show exactly how the atomic-hydrogen welding process is used. In the scene above an operator demonstrates the proper application of filler metal.



PROPER ADJUSTMENT of the atomic-hydrogen holder, the hydrogen supply and the welding current is clearly illustrated. Each step is shown by close-up photographs.

THE ATOMIC-HYDROGEN ARC and molten pool are shown in full detail—by the new technique developed by the Raphael G. Wolff Studios of Hollywood.

FINISHED WELDS of typical joints are illustrated by surface and cross-sectional photographs. The causes of both good and bad welds are fully explained.

**THIS COUPON IS YOUR KEY TO FASTER TRAINING**

**JOE MaGEE, General Electric Co., Dept. 673-49**

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(nearest address)

☐ **Enclosed is our order for "The Inside of Atomic-hydrogen Arc Welding," Part 1 and Part 2.**
*(We understand that if we are not completely satisfied we may return the films within five days, and our order will be cancelled.)*

☐ **Please reserve Parts 1 and 2 for our use on date indicated:**

1st choice..... 2nd choice.....

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(Organization)

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(Your name)

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(Street address)

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(City) (State)

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IF your problem is one of transmission of power or control "around the corner," you will generally find the answer in Walker-Turner Flexible Shafting.

For many years this Company has been one of the largest manufacturers of flexible shaft machines for industry. Constantly improving the design of our machines, we have brought the component parts to a high state of development — including the shafting. Our wide experience in this field has caused us to be consulted by other manufacturers of mechanical products. As a result, we have assisted in designing this form of power transmission and control in many applications outside the machine tool field. Much of this work is in connection with aircraft and other war machines.

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Your engineering department may save much valuable time by consulting us on any problems involving the use of Flexible Shafting.

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## FLEXIBLE SHAFTING

FOR REMOTE CONTROL AND POWER TRANSMISSION

# SIDE SLIPS

• It's all set. When the war's over, the aircraft industry is going to re-tool for helicopter and small-plane production in about 90 days. A professor says so, and he urges that over-night parking facilities be built to take care of all these craft.

Now if he'll only figure out just how to re-tool that quickly, and set up sales organizations, and get some cash on which to operate . . .

• Theme song for aircraft personnel directors: "Tell me pretty maiden, are there any more at home like you—or anywhere?"

• One of the larger oil companies takes some pains to point out that the cargo plane isn't likely to replace the ocean-going tanker. One of the clincher arguments was that "if a 70-ton aerial freighter similar to the *Mars,* largest transport now in existence, were to load enough fuel for a round-trip flight to Egypt, it would have to fly with empty cargo space." It doesn't say how much fuel a tanker would burn between Galveston and San Francisco, going via Cape Horn—which would be just about as smart as loading a plane for a round-trip jump to Egypt.

• Recently a famous movie and radio star (shall we say the one who scared the daylights out of the East with a Mars invasion broadcast?) went to a plane factory to participate in a family-day program. He was hidden away in an executive office to await his cue. As will happen in executive's offices, the phone rang. Being longely he picked it up—but started a tirade in a swell German accent, finally hanging up to leave the caller completely baffled. Soon—as will happen—the phone rang again. And this time he cut loose in just as swell a dialect, but this time Italian. Again he hung up to leave a caller dazed.

It was a persistent phone, though, and again it rang. He picked it up and in a high voice shouted, "So sorry prease, no time to talk now, Japanese spy very busy making sketches of 'Merican bombers, goodbye prease."

• It's a rare case when aircraft engineers tell a pilot "our plane won't do that." But one of those man-bites-dog things happened when Maj. Alvin Mueller, formerly of the famed 19th Bombardment Group, returned from the South Pacific and quietly reported to Consolidated engineers that he'd flown 59 men, mostly plane-less fighter pilots, from Mindanao to Australia in one of their B-24 *Liberators.* The engineers even went so far as to get out their slide rules to prove he couldn't do it, that they simply hadn't designed the ship for any such job. But, since the Major had loaded them in from nose through bomb racks almost to the tail—and counted 'em out again at the end of the trip—he knew it had been done. And he knew they were in the plane all the way, because most of them were breathing down his neck. Not that he blamed them, there just wasn't anyplace else to look, because he flew that *Liberator* on instruments almost every one of the 1,700 odd miles.

• Most everyone realizes what a magnificent job our airlines have done, flying more people and things more and more miles with less equipment. There's no question that they deserve all the credit and more. But there's another bouquet to be passed on, one we rediscovered on our last regular coast-to-coast trip. It's this: the airlines haven't lowered their courtesy standards one iota. With people literally crying to get space, the lads—and now the lassies—still make you feel you're doing them a favor to give 'em some business. Even when they have to bump you for priorities, it's almost impossible to hold a grudge. It's a lesson at least one other transport medium could well learn; one we sincerely hope and believe the airlines won't forget.

**Maguire has been overdoing this silhouette identification stuff since joining the spotters service.**

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Aircraft manufacture—America's No. 1 industry today! Making the best, the fastest, the hardest hitting planes ever built—*and more of them!* Beating quotas and schedules — setting a new pace for fast and precision production. » » » And right in step—Wesson Carbide Cutting Tools establish new standards for cutting tougher metals, faster —*with precision and perfection never before attained.*

Wesson leadership, recognized in aircraft motor production, will meet the challenge of new and finer "tooling up" for post-war production.

The counsel of Wesson engineers — skilled in engineering and designing of cutting tools — is available to help solve present war production problems, or for post-war planning.

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First choice when tough metals are to be cut — for special or standard purposes — for single or multiple setups.

**WHEN IT'S OVER "Over There"** we'll all have a higher standard of living "over here." Better vacuum cleaners, refrigerators and washing machines—better cars, trucks, planes, bicycles — better tractors, plows and other farm machinery. Industrial plants will have better tools and better machines.

They will all serve better, last longer, cost less and be safer. One important reason is that Wesson Carbide Cutting Tools will enable the manufacturers of all these products to use more durable, tougher metals — insure greater precision and perfection — and at the same time cut costs by saving production time.

# The *Flash* of a TAILLIGHT helps bring in the *Clippers*

## ...reliably timed with the W&T FLASHER MECHANISM

When the ships of Pan American Airways' great Clipper fleet come in, they show the same familiar taillight flash that now marks all America's commercial planes. And the mechanism which times this flashing red-white signal on the Clippers is the reliable W&T unit, just as it is on a large majority of all our airlines.

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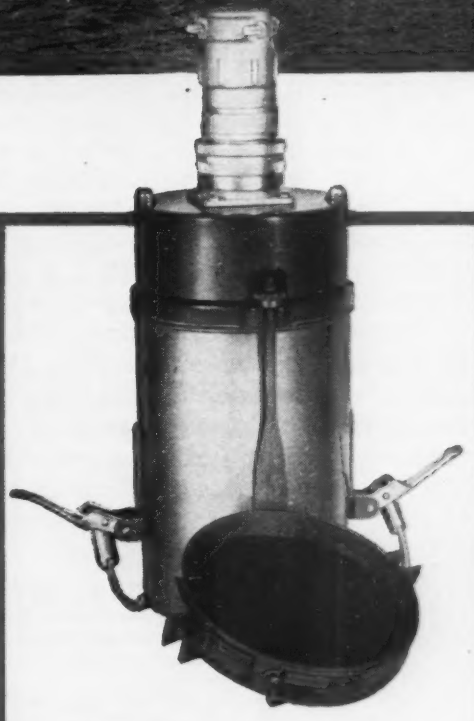
A-6



**W&T FLASHER MECHANISM**

Types: FA121 for 12 volt operation
FA122 for 24 volt operation

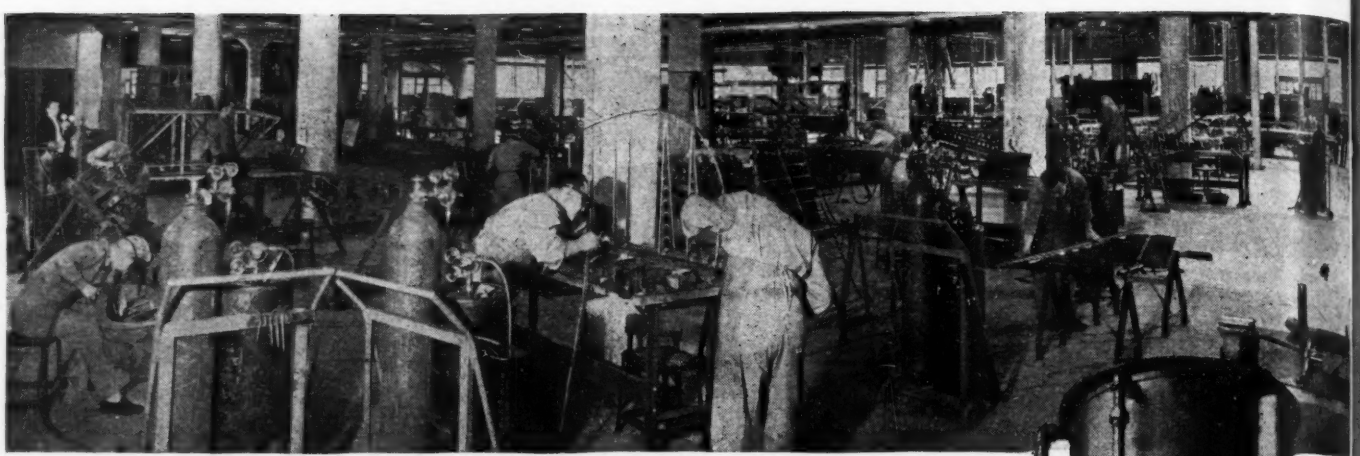
Write for Technical Publication 234.

ARMY E NAVY

VIP

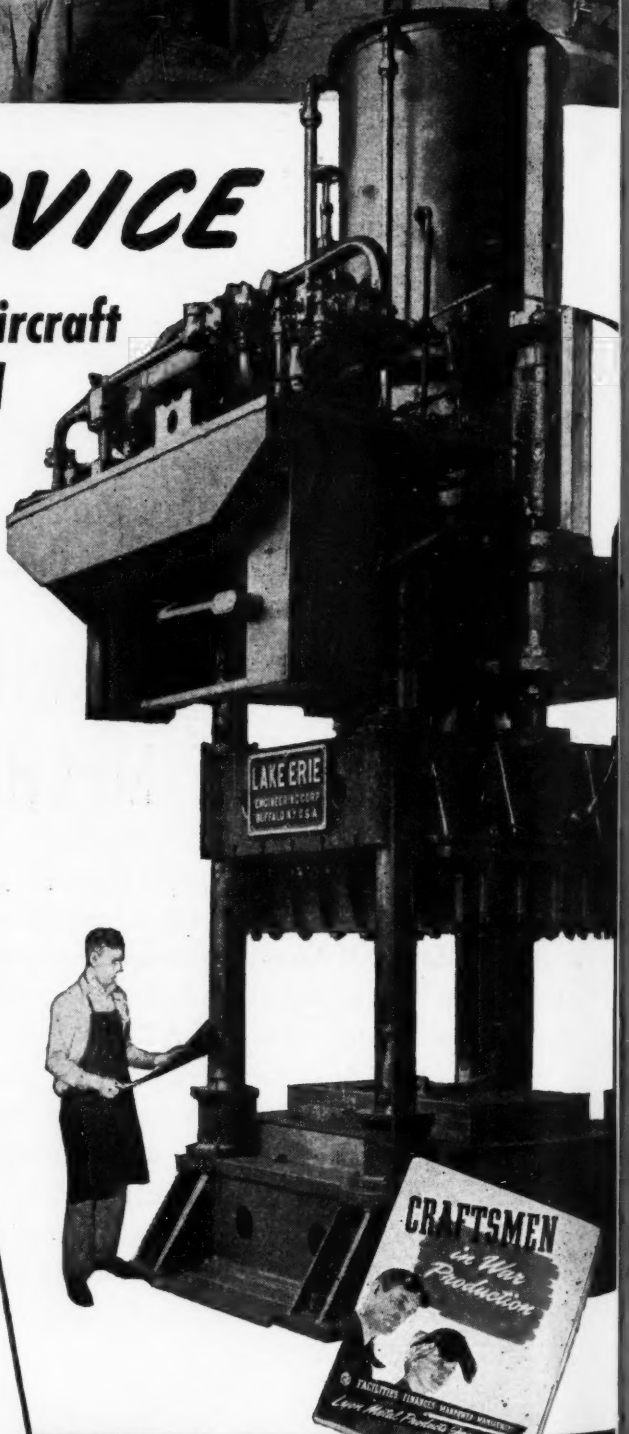
**WALLACE & TIERNAN PRODUCTS, INC.**

BELLEVILLE, NEW JERSEY



# AT YOUR SERVICE

## Open Facilities for Production of Aircraft Parts in Aluminum and Steel




● Lyon is at work on a wide range of contracts for aircraft parts and sub-assemblies in steel and aluminum.

Our modern, completely equipped Aircraft Division is supervised by men specially trained in aircraft plants. Class "A" certified welders trained in our own school are available for all aircraft work. Completely equipped toolrooms, staffed with experienced tool and die makers, are capable of producing dies, fixtures and jigs to meet contract requirements. Lyon has had 43 years' experience in sheet metal fabricating operations. Our war contract experience dates from July, 1940, and we are entirely familiar with Army, Navy and other Government inspection requirements.

Phone, wire or write on your business letterhead for detailed information and book, "Craftsmen in War Production," describing and illustrating Lyon plants and equipment.

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*General Offices: 5805 Madison Avenue, Aurora, Illinois*

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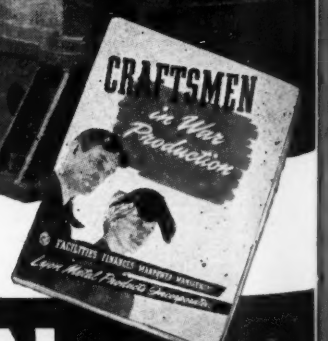


**Lyon's Extensive Production Range Includes:**

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- Complete assembly work, including both welding and riveting.

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## SUBCONTRACTORS SECTION

# Subcontractors May Borrow Up To $25,000 From Smaller War Plants Corporation

Regional loan agents of the Smaller War Plants Corp. may, under authority recently granted by the War Production Board, make loans up to $25,000 to prime or subcontractors engaged in war work who need additional working capital or money for acquiring additional production facilities for war work.

This new aid is in addition to the regular financial service offered by WPB through its regional offices to assist manufacturers in securing financial aid from normal private capital.

In seeking loans under the new setup, contractors should contact their own regional WPB office rather than write to, or to go to, Washington, it is pointed out by SWPC officials.

Making these loans available is in line with policies outlined by Col. Robert W. Johnson, chairman of the Smaller War Plants Corp., who has repeatedly urged greater subcontracting both as a means of increasing the nation's production and to promote maintenance of the type of business which has proved so important in peace times.

## Men and Machines Available for War Work

*Production facilities—plants, precision tools, and skilled operators—are available to further the war effort. To bring prime and subcontractors together, AVIATION offers this clearing-house of information. Address inquiries, with reference to accompanying key number, to AVIATION, 330 W. 42nd St., New York.*

### Metal Work Facilities.....S-146

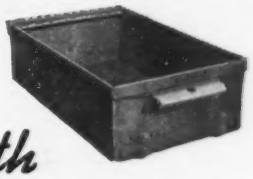
Air circulating equipment manufacturer, now making parts for American fighter planes, has facilities available for more aircraft work. Factory has 33,000 sq.ft. of floor space, railroad siding, truck dock, and fire and plant protection systems. Organization has its own tool shop and is making Kirksite, Cerromatrix, Masonite, and steel dies, also is licensed to make Continental blanking dies. Has rubber pads available for aluminum forming and is doing considerable welding of aluminum and steel assemblies.

Officials report that company is particularly interested in assembly work as well as fabrication of heat-treated aluminum stampings.

Welding equipment includes two each of the following: 150 amp. Lincoln d.c.; 15 kva. Ace model spot welders; Mecco Gas Welding and cutting sets and 22 kva Federal gun welders; one each of the following: 275 amp. Marquette a.c.; 300 amp. Una; 15 kva. Taylor Winfield spot welder; 10 kva. and 30 kva. Thompson Gibbs spot welders. Cutting equipment includes one each of the following: 18 ga. 42-in. Niagara power square shear; 12 ga. 49-in. and 14 ga. 120-in. F.A. Ohls power square shears; 14 ga. 30-in. Pettingill ring and circle shear; 16-in. Type ML Doall metal saw and a 2x2x¼-in. Whitney angle notcher. Blanking and forming units are as follows: Presses—65 ton Bliss No. 6 Consolidated OBI; 40-ton. Cleveland No. 6-1 OBI; 105-ton double-crank Toledo punch press; 22-ton Styles type; 18-ton Bliss No. 19 OBI; 14-ton. Bliss No. 18 OBI; 14 ga. 60-in. and 14 ga. 10-ft. Dries & Krump press brakes; 18 ga. 120-in. Dries & Krump hand brake; 18 ga. power flanger and 18 ga. 36-in. bending rolls. Finishing equipment includes: Two 6x6x7 Binks spray booths; three complete Binks spray sets; a 30-ft. circular drying rack; an 80-ft. roller drying conveyor; three caustic cleaning tanks and two power buffers and grinders. Machine shop contains a 14 in.x6 ft. Sebastian screw cutting lathe; 9 in.x3 ft. Craftsman tool room lathe; a 7-in. Ajax special shaper; two power hack saws; a 12-in. table


SAVE TIME

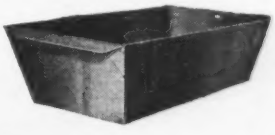
HANDLING PARTS IN PROCESS



*with*

LYON

MATERIALS HANDLING CONTAINERS



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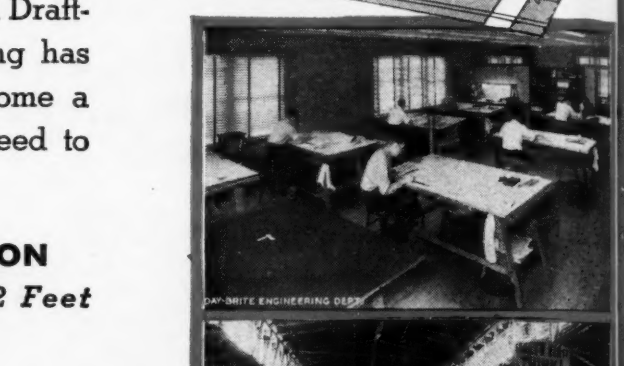

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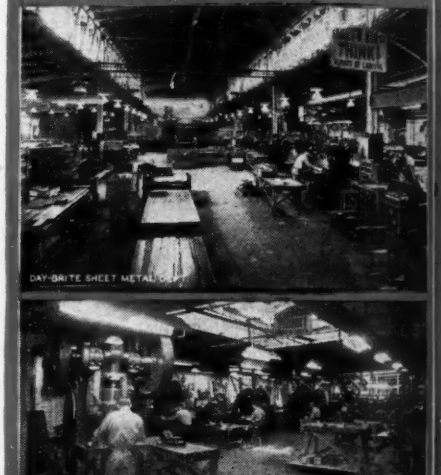


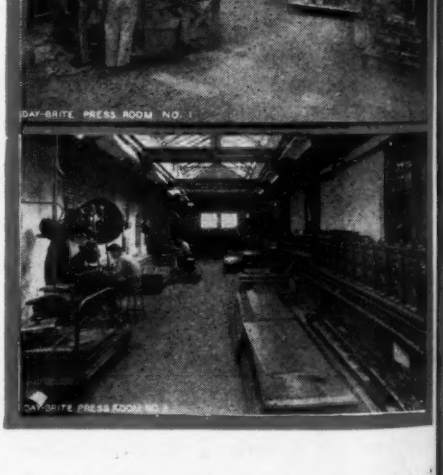

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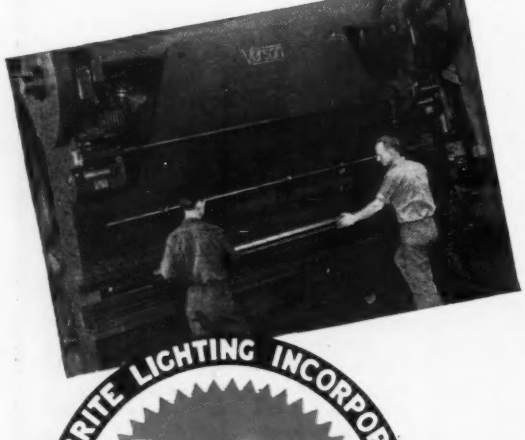

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saw; a Delta Hi-speed cutoff saw; a 30-in. Ajax dynamic balancing machine; two 30-in. static balancers; a 1-in. Barnes drill press; two ½-in. drill presses; a No. 2A-HD 2,600 high speed riveting hammer; and four No. 161 J. L. Thompson tubular riveters; No. 2 Brown & Sharpe plain milling machine; 14 in.x10 ft. Barnes engine lathe; Hendy 16-in. 3 hp. shaper; 6x13 in. Delta surface grinder and 14-in. Delta drill press with tapping equipment. Facilities are also available for heat treating aluminum (12x3x4½ ft. salt bath) and for anodizing (14x5x3 ft.), both processes being AN approved.

**Wood, Metal, Fabric.....S-147**

Large, well established New England aircraft operating company now owning, operating, and servicing 125 airplanes of every type, has facilities for production of aircraft parts and subassemblies of welded steel, wood, metal, and fabric. Now producing welded steel structures for the Army Air Forces on subcontract basis, company has total of 31,275 sq.ft. available, with more space in immediate vicinity if necessary. Good labor source is available, since the organization operates a government-approved Mechanics' School with 75 to 100 students always in training.

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COLORADO SPRINGS, COLORADO
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# Instrument Approach By Radio Direction Finder

***Part I***

**By C. H. McINTOSH,** *System Chief Navigator, American Airlines*

**Accurate methods of approach by loop direction finder, using non-directional radio beacons, are now of prime importance in aircraft operations abroad where familiar radio ranges are absent. Here no-wind to moderate-wind conditions are covered. Higher wind conditions will be considered in Part II, to follow in an early issue.**

IN RECENT YEARS the increasing availability of radio direction finding equipment on aircraft manufactured in this country has promoted a quickening appreciation of the navigational possibilities of radio D/F. Many of these possibilities have received sufficient attention by now to be reflected in pilot practices. Particularly is this trend noticeable in the increased use of radio bearings for determination of position and the widespread tendency of pilots to rely on loop orientation methods in preference to the older systems of radio range orientation.

Within the United States, however, the prevalent and accepted practice of using the radio range for instrument approaches has obscured the possibilities of the direction finder for this same purpose. As a result, many pilots have seldom recognized these possibilities. Or if they have, they have not the advantage of sufficient schooling in D/F approaches to fully understand the employment of direction finding equipment. During the past year, however, the demands of air transport have carried an ever larger number of pilots beyond the continental limits of the United States—into regions where the familiar radio ranges are either non-existant or so scarce as to be seldom encountered. In many of these regions, however, non-directional radio beacons are common equipment and can be safely used in conjunction with aircraft D/F equipment to execute an instrumental approach.

While there exist numerous methods of executing an instrument approach by means of D/F equipment, it is felt by the writer that sufficient misconceptions exist regarding the purpose and execution of these methods to warrant a fresh approach to the whole problem.

As in all instrument approaches by radio, certain specific information must be known to the pilot prior to starting a procedure. These are:

1. Bearings of the airport runway, or runways.
2. Location and bearing of radio station from the airport.
3. Distance from radio station to airport.
4. Field elevation.
5. Elevation of surrounding terrain and other obstructions.

With the above facts known for any specific airport, it is, of course, in the interests of safety to draw up a specific D/F approach procedure for that airport rather than attempt to set up our type of approach procedure to fit all airports. Definite minimum altitudes must be set up for each airport. In the absence of a specific procedure tailored to fit an airport, it is possible for a pilot to devise one, provided he understands the general principles involved in all instrument approaches with the D/F. Two types of such procedure will be explained:

### General D/F Approach Methods

We will, in these procedures, assume an approach is being made to an airport with one runway 5,000-ft. long laid out 90–270-deg. magnetic. A non-directional radio beacon is located 2 mi. from the west end of this runway. A safe minimum altitude for instrument descent over this airport is assumed to be 500 ft. above sea level. Due to location of the radio beacon in relation to runway, the direction of final approach is 90-deg. magnetic.

Two types of D/F procedures can be designed to effect a safe instrument approach to such an airport. In the first procedure, these three basic problems are involved:

1. Location of station (if necessary by a loop orientation) and homing to it.
2. Execution of a "boxing" procedure on station in order to determine existing wind conditions.
3. Execution of instrument descent to desired minimum altitude in such manner as to line up with runway in a position to land if ground contact is established.

The second type of procedure eliminates the need of a boxing process although both Steps 1 and 3 specified above are necessary. In both procedures, Step 1 is executed in the same manner. We will call this the initial approach.

For maximum safety and reliability, all D/F procedures are based upon aural null and manual loop operation.

Naturally they can be executed more easily with an automatic radio compass.

### A. Initial Approach

1. If in doubt, establish location of radio station by means of a loop orientation.

2. Home on the station by a straight track after correcting for drift.

3. As homing track brings airplane closer to station, pilot will be furnished a rough approximation of his relative distance from it by rapidity with which he must adjust volume control to maintain a constant width null. Every attempt should be made to maintain this at a constant 5-deg. width, checking it frequently by rotating loop from side to side in order to ascertain exact edges of null.

4. As station is closely approached, pilot receives sufficient advance warning through increasing rapidity with which null width decreases until at last it becomes impossible to maintain it. At this point, aircraft is entering what normally would be inverted "cone of silence" above station.

5. Within "cone," loop null disappears and in its place pilot receives a distinct surge of signal. In D/F terminology this approach over station is termed an "over."

With sufficient practice a pilot can become reasonably skillful in determining definite "overs" provided care is exercised on the following points:

a. Checking of null frequently as station is approached. When surge over station is obtained, there should be no doubt that null has been replaced.

b. Maintaining sufficient altitude on initial approach over station, or slow airplane down so that surge will be of sufficient duration to allow its positive identification. This should not be less than 3,000 feet at 120 mph.

c. Double checking "over" after station is passed by reappearance of null.

6. An alternative method of obtaining an "over" for determining station passage is to pass deliberately to one side of the station. This is termed obtaining an "abeam." To accomplish this properly, the station should be "homed on" as described previously. Just prior to reaching the station, however (as judged by volume-null width relationship) heading of the aircraft should be changed approximately five degrees downwind in order to pass station on one side. By rotating loop to follow the null, it is easy to determine when the station is passed.

### B. Boxing the Station-No Wind Pattern

1. After passing either over or abeam of the station, make a standard rate turn to a heading which is 45-deg. less than the intended final approach track.

(*Turn to page* 371)

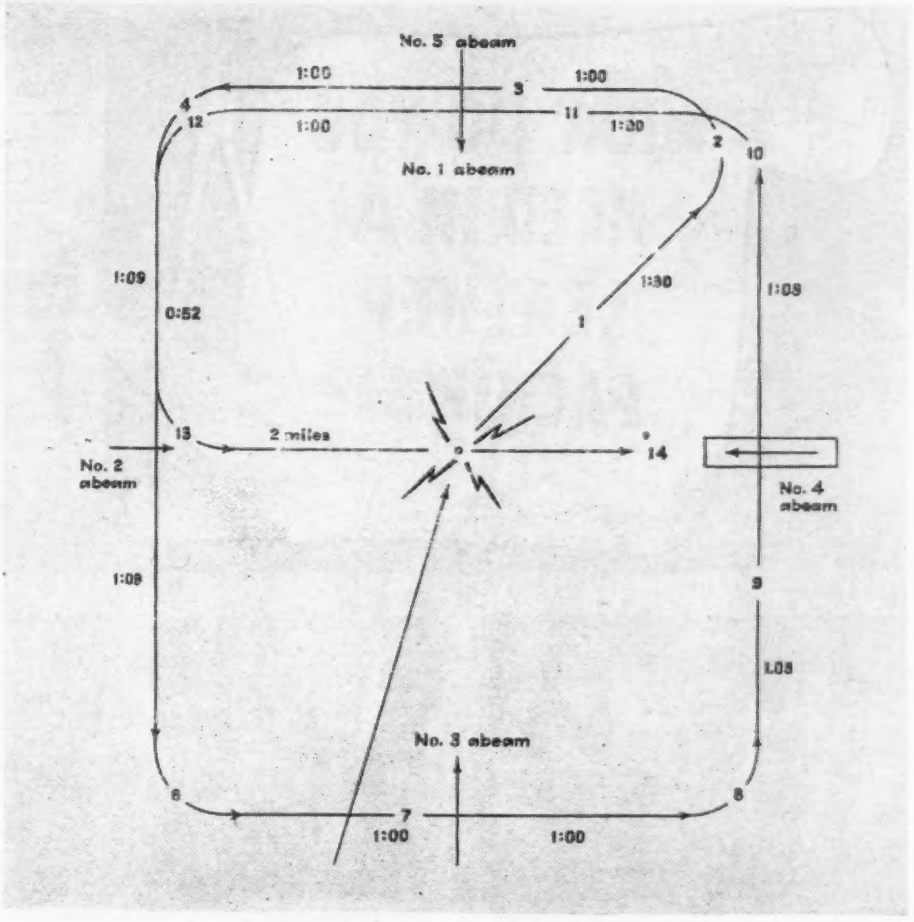



Fig. 1. Boxing procedure—no wind.

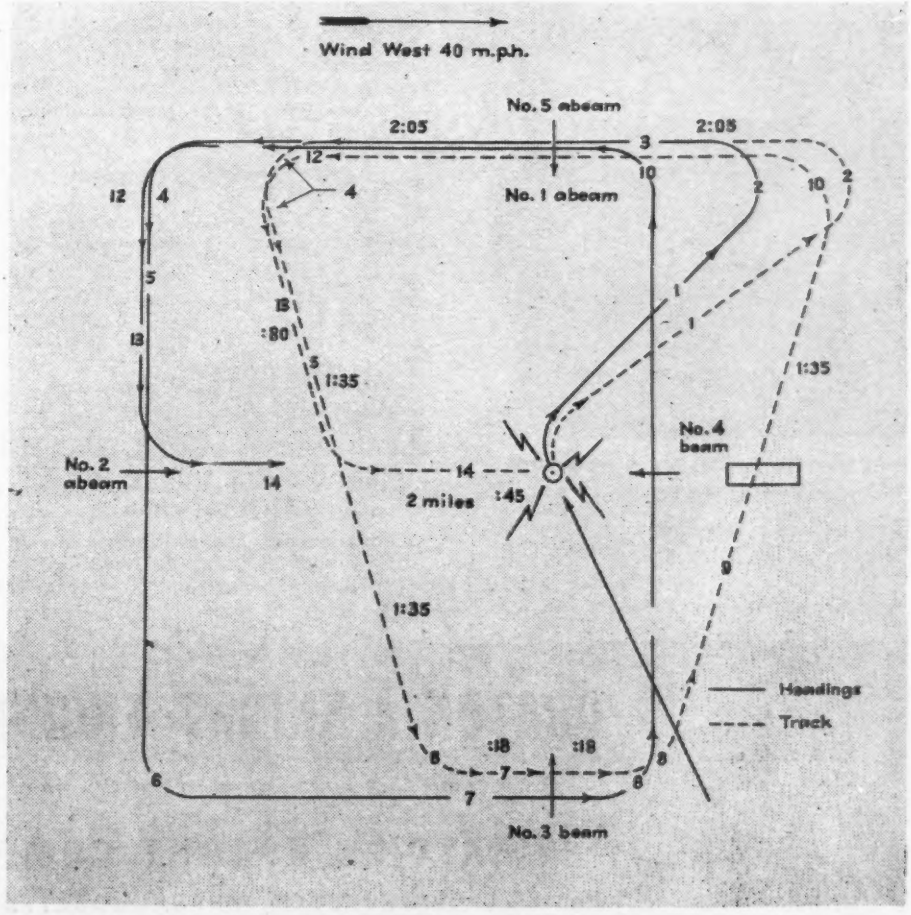


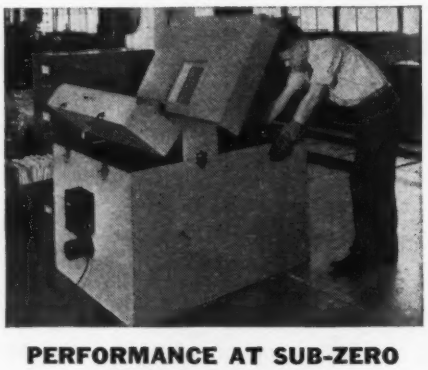

Fig. 2. Boxing procedure—compensating for wind.

# WHAT DO YOU NEED IN A LEATHER PACKING ?

Your packings requirements usually present Graton & Knight with a ***development*** problem . . . for few orders can be filled from the shelf. Operating pressures, temperatures, mediums, speeds are a few of the factors influencing a recommendation — the soundness of which depends not only on selection of the proper material and versatility of our manufacturing, but also on the experience and development facilities of our engineering staff. Our experience is proved by our engineers' high standing among manufacturers using packings . . . the facilities are sampled below —

**HOT OR COLD OPERATION?**

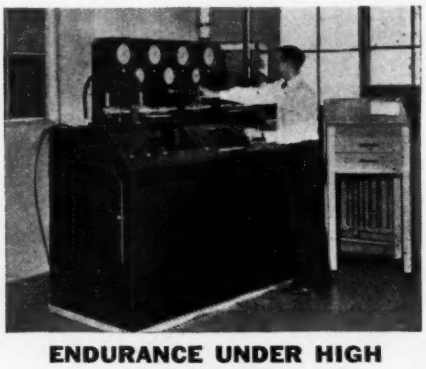
On this test stand*, assembled packings are tested under controlled temperature conditions ranging from 65°F. below zero to 200°F. above.



**PERFORMANCE AT SUB-ZERO TEMPERATURES?**

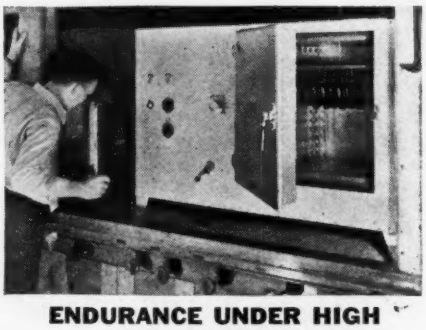
Here packings materials are tested for resistance to temperatures down to 95°F. below zero.

* Built for us by Denison Engineering Company.



**ENDURANCE UNDER HIGH PRESSURES?**

Continuous operational cycling tests made on this unit* at pressures up to 2000 psi, determine life expectancy of any packing type or material. Leakage can be observed and measured in drops. Other equipment runs tests at higher pressures.



**ENDURANCE UNDER HIGH TEMPERATURES?**

In these ovens, changes in physical characteristics of packings materials are observed under constant, elevated temperatures.

## SPARTAN

**—acknowledged the top-quality packing leather**

Graton & Knight's exclusive "combination tannage" produces a superior leather having chrome leather's resistance to heat and oil plus a mellowness and a flexibility not found in the usual chrome tannage. Spartan has highest resistance to heat and remains flexible at extremely low temperatures. It will not dry out hard and brittle. It is usually selected for applications within the extreme limits of leather's adaptability to packing requirements.

*The world's largest industrial leather plant*

Have Graton & Knight engineers tackle your packings problem while your equipment *is in the design stage.* Sometimes a slight change in *equipment design* will result in greatly improved performance and longer life.

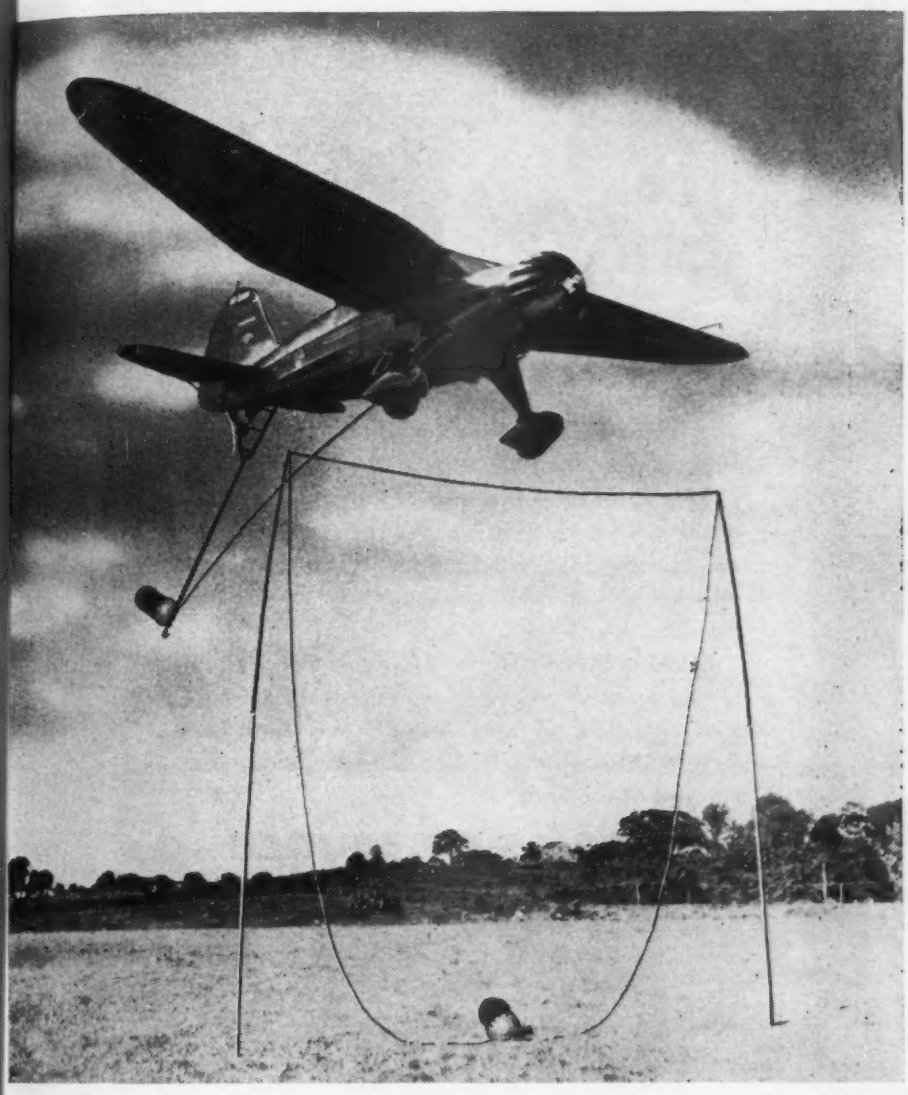
**GRATON & KNIGHT ENGINEERING**

*the hand that builds certainty at the point of seal*

**GRATON & KNIGHT COMPANY**

**WORCESTER, MASSACHUSETTS**

GRATON AND KNIGHT



AIR TRANSPORT

**Will pick-up system,** such as that successfully operated by All American Aviation, be classed separately from feeder operations? Or will it be considered as part of "standard" feeder operations? This is one of major problems which will face industry and CAB early in postwar development.

# Feeder Airlines Pose Problems

By JOHN H. FREDERICK, Ph. D.
*Professor of Transportation, the University of Texas*

**Industry and CAB face four major decisions in development of new and vital part of nation's postwar transport system.**

As soon as the war is over and equipment and manpower again become available for commercial air transport expansion, we will see a veritable horde of applications presented to the Civil Aeronautics Board for certificates of convenience and necessity covering feeder airline operations. The flood had already started to descend on the CAB before Pearl Harbor, since by Dec. 15, 1941, some 42,000 mi. of feeder services, involving more than 1,500 stops in 34 states, had been applied for.

No hearings had been held on applications for strictly feeder airline operations involving more than a pick-up service prior to our entry into the war and, with suspension of all new route hearings on which the record had not yet been made, all feeder airline applications were automatically put aside until after the close of the war. Shortage of equipment and manpower and some uncertainty on the part of the CAB as to disposition of the pending applications brought the postponement. It was doubtless wise.

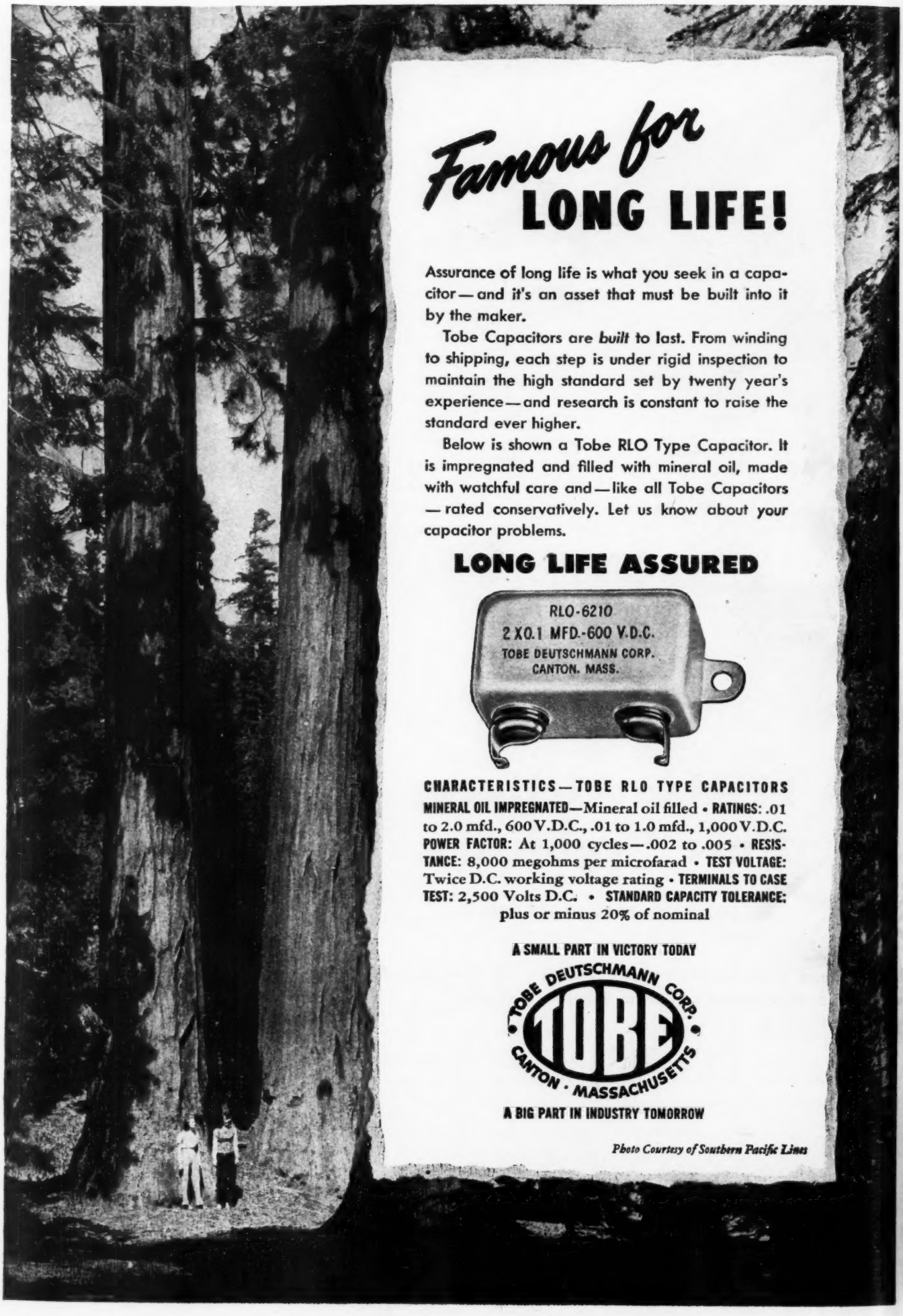
However, before the time comes when all the feeder airline applications will be heard, probably in order of their filing if the board sticks to its customary procedure, it is well to look at some of the problems with which the CAB and the industry will be faced. These problems are:

1. To define a feeder airline.
2. To decide on what type of operations, pick-up or standard, should be encouraged and under what circumstances.
3. To decide who should be permitted to engage in feeder ariline operation.
4. To set a standard procedure for feeder airline hearings so as to avoid duplication of proof of convenience and necessity whenever possible.

Perhaps the first problem is that very few agree on just what a feeder airline is. The CAB has not yet drawn a clear distinction between the character of the type of operations which might be termed "feeder" and the type comprising trunk-line operations. Everyone in the industry seems to have his own idea of what a feeder is or should be, and the CAB can hardly be blamed for not taking a position on the matter until the first feeder airline application is heard. Certainly at that time some sort of a definition will have to be a part of the evidence presented.

Generally, a feeder airline has been thought of as the type of air service which will connect small centers of population with the primary or trunk lines of the country. This type of service has been referred to in past years by such terms as "auxiliary air route," "feeder line," "belt line," "branch line," or "supplementary air route." Little wonder there is much confusion today as to the type of service contemplated when one speaks of a feeder airline.

As long ago as 1938, B. E. Cole, then president of the Airlines Charter Service, defined a "feeder air route" as "any air route on which the average distance between terminals is 75 mi.



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Below is shown a Tobe RLO Type Capacitor. It is impregnated and filled with mineral oil, made with watchful care and—like all Tobe Capacitors—rated conservatively. Let us know about *your* capacitor problems.

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**MINERAL OIL IMPREGNATED**—Mineral oil filled • **RATINGS:** .01 to 2.0 mfd., 600 V.D.C., .01 to 1.0 mfd., 1,000 V.D.C. **POWER FACTOR:** At 1,000 cycles—.002 to .005 • **RESISTANCE:** 8,000 megohms per microfarad • **TEST VOLTAGE:** Twice D.C. working voltage rating • **TERMINALS TO CASE TEST:** 2,500 Volts D.C. • **STANDARD CAPACITY TOLERANCE:** plus or minus 20% of nominal

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TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

**A BIG PART IN INDUSTRY TOMORROW**

*Photo Courtesy of Southern Pacific Lines*

or less, excepting routes in operation and carrying air mail on Jan. 1, 1939." At best this definition sets the date on which feeder routes might begin to exist. Short-haul routes of the trunk lines, which might be classified as feeder routes, would be excluded from that category by such a definition while "any route on which the average distance between terminals is 75 mi. or less" that might come into existence after Jan. 1, 1939 would automatically become a feeder route. About all such a definition would do, if officially adopted, would be to guarantee the status of the present trunk-line operations.

Also, what is meant by the use of the term "route" in such a definition? Does it mean the entire operating area of the feeder airline, or does it refer to a single operating division of the feeder airline as a whole? Certainly such a definition would find few adherents in the industry today.

Airline Feeder System, Inc., which operated in 1937 and 1938 but failed to obtain a certificate of convenience and necessity under the "grandfather clause" of the Civil Aeronautics Act of 1938, held that a "feeder system was one which will operate within an approximate radius of 200 mi. of any given airline terminal to give the cities within that radius mail, passenger, and property service." Just as in Mr. Cole's definition, an attempt is here made to limit the physical area over which a feeder airline may operate. Few will agree, however, that the geographical area to be covered is the only characteristic by which feeder operations may be distinguished from trunk-line operations. Moreover, it is difficult to visualize just what is meant by a "system." Perhaps system was used here to describe the operating limitations for a feeder airline as a whole or in an attempt to delimit the physical area to be covered by a single feeder.

The two definitions cited are pretty rigid. Less rigid is one suggested by Robert J. Pritchard—that "a feeder line is a line which connects communities off the main line with the main line, and by so doing feeds into the major artery the mail, express, and passengers that originate in the hinterland or outlying regions." Another more liberal definition was that of Keith Kahle who, in 1941, suggested the following: "A feeder service is a short air route operation which gives airmail, passenger, and express service, or airmail and express service, to cities and towns not now enjoying scheduled trunk line service by a domestic carrier."

The first two definitions quoted—those of Mr. Cole and Airline Feeder System—appear to be too rigid, while those of Messrs. Pritchard and Kahle would seem too general. Whether or not the type of air carrier service performed is of the nature of feeder or trunk line operations should certainly not be determined on the sole basis of long or short haul, though distance between stops is a factor to be considered. Nor should the fact that a city or town is or is not served by a trunk airline be a logical criterion for determining the type of service offered.

Since none of these definitions are felt to present, in themselves, an adequate statement of what a feeder airline will be, the nature of feeder airline operations, as they seem to fit into the picture, might well be compared with those of the trunk lines. At least, any

(*Turn to page* 378)

**Special equipment for feeder line operation** will undoubtedly be developed as this type of operation grows. Its early growth, however, may see widespread use of planes converted from war craft such as this Fairchild AT-14 *Yankee Doodle* now being employed by the military as bomber crew trainer.

# NEWEST TROOPSHIP

Originally designed to whisk 55 passengers from coast-to-coast, non-stop in 9½ hours, this amazing Lockheed "Constellation" now is the World's fastest troop carrier. After the war, these Constellations will be TWA's coast-to-coast luxury liners.

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*More revenue airline miles in the U. S. are flown with Texaco than with any other brand.*

So effective have Texaco Lubricants proved that they are definitely preferred in many other important fields, a few of which are listed in the panel.

A Texaco Aviation Engineer will gladly cooperate in the selection of Texaco Aviation Products, available at leading airports in the 48 States. Phone the nearest Texaco distributing point, or write The Texas Company, *Aviation Division,* 135 East 42nd St., New York, N. Y.

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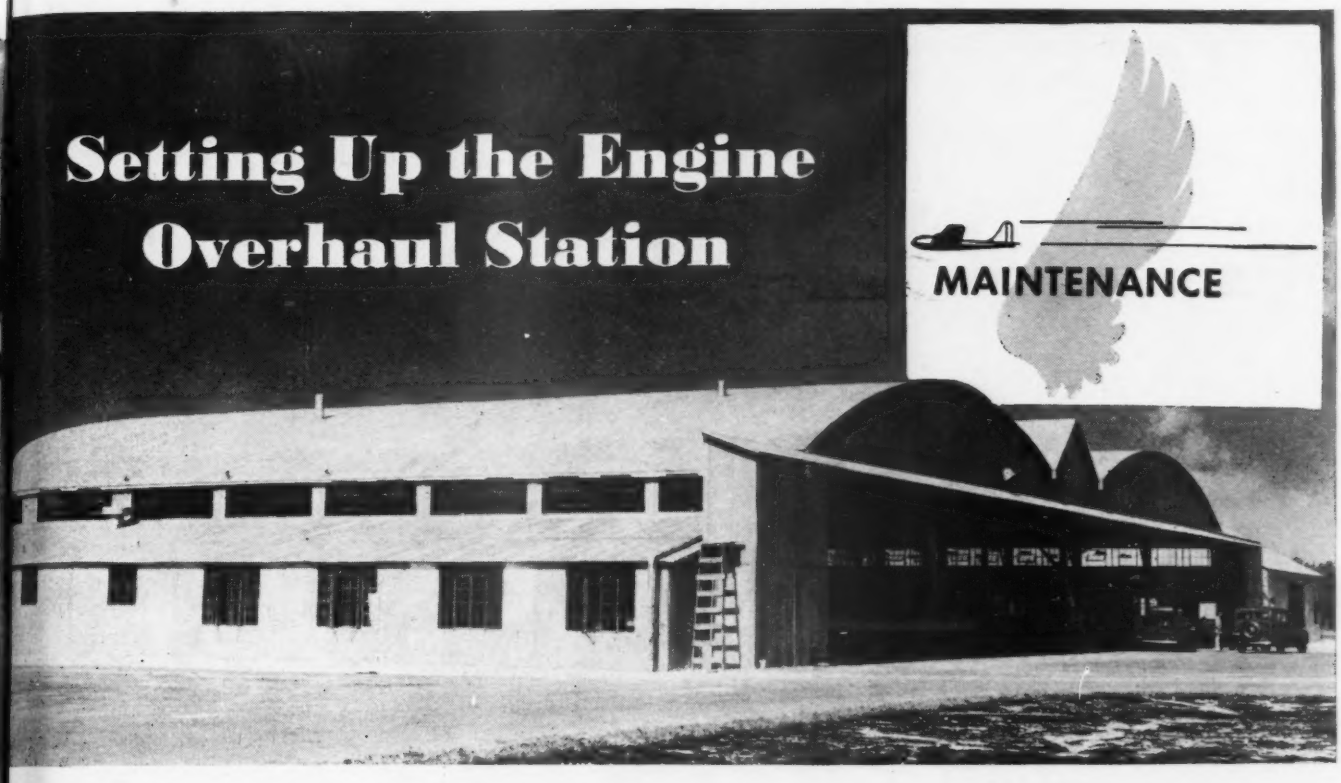
TUNE IN FRED ALLEN EVERY SUNDAY NIGHT—CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

# Setting Up the Engine Overhaul Station

MAINTENANCE



By JOSEPH R. HORTON

*Vice-President and Maintenance Superintendent, Embry-Riddle Co.*

**Expansion of overhaul facilities to maintain the Army's training planes have been a major problem, requiring ingenuity and hard work — plus. Here's how the Florida Embry - Riddle School licked shortages of men, materials, and time.**

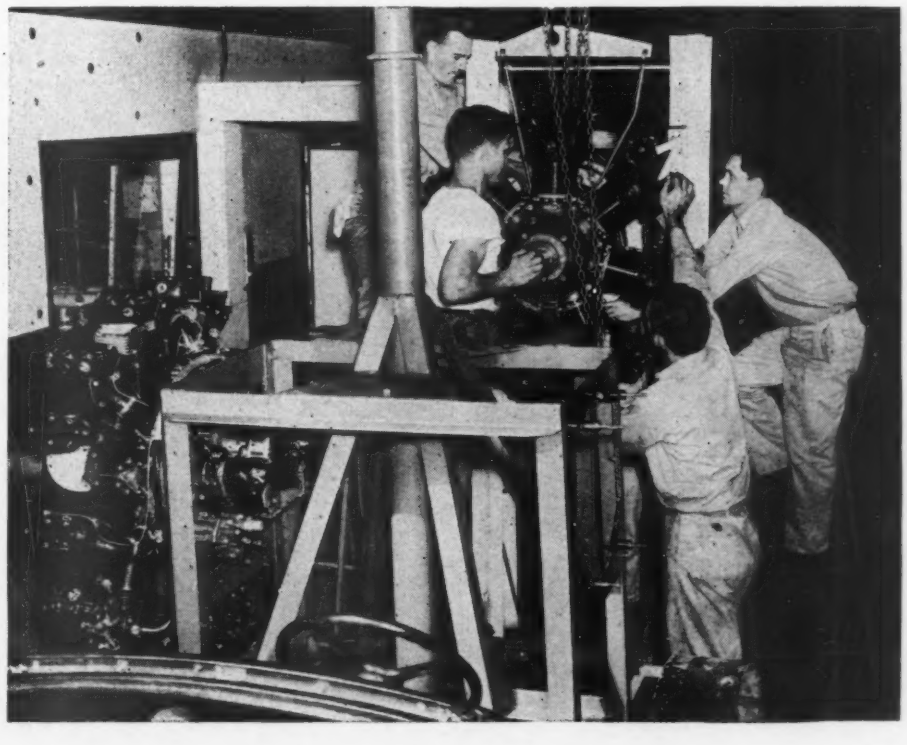
After Dec. 1, 1941, demands for engine overhaul work poured in upon U. S. Army depots at such an overwhelming rate that it became impractical for these depots to handle both training and tactical engines at the same time. The work had to be farmed out to certain operators capable of taking the work. Since government orders specified that new construction must be kept to a minimum, no priority or assistance was available from the armed forces.

Embry-Riddle Co. in Miami, Fla., was one of those which already had repair facilities adequate to accommodate its own overhaul work. The Army, however, asked that these facilities be enlarged so that the depot could handle training engines, which were constantly reaching their 600-hr. mark at the flying schools, where primary flight training was being given cadets.

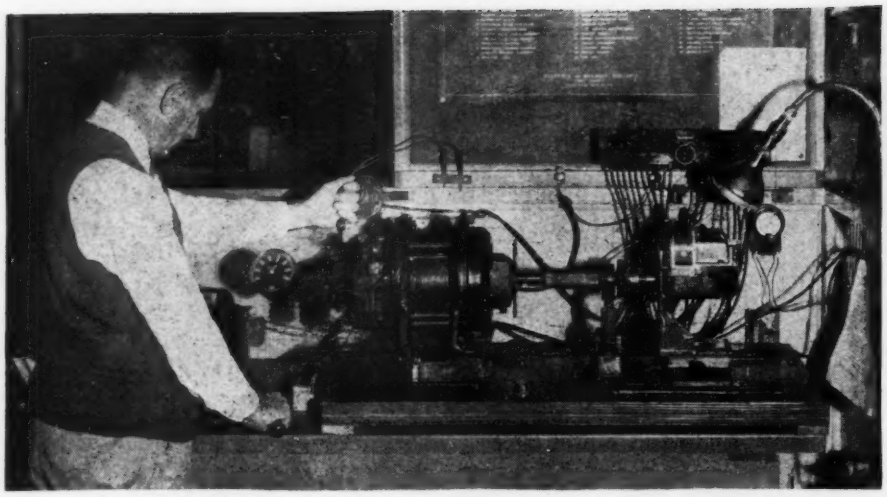
John Paul Riddle, president of the school, agreed to provide this overhaul service for the Army. That was in June, 1942. Four months later, the station was in full operation, turning out its assigned quota of overhauled Continental R670-5 engines daily.

The station was ready despite the fact that at the beginning inadequate personnel was available and that materials were scarce and in many cases could not be secured at all. It was ready despite the fact that machinery and tool manufacturers, already swamped with unfilled orders, could only shake their heads sadly in reply to order requests.

How these things were accomplished



**An old Model A Ford coupe,** stripped of its body and equipped with boom and carrier mounts, transports finished engines from overhaul line to test stand, a block away. Here a reconditioned engine is being transferred to the test stand.



**Magneto testing equipment** was built by crew from an old Wiedenhoff automotive starter and generator test stand—in line with policy, "If you can't buy it, make it."

**Women solved one of labor problems.** Starting as inspectors, they were soon used in other departments, now constitute one-third of employees. Photo shows visual inspection at left and in foreground, magnetic inspection in background and right center.

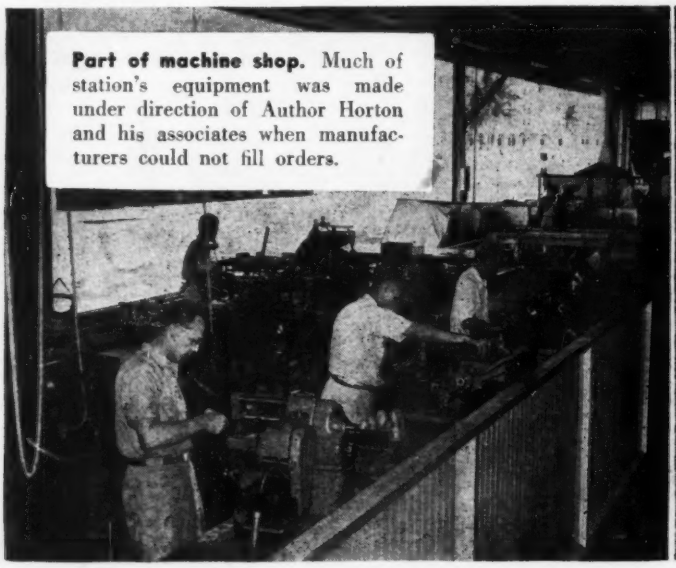
is a testimonial to hard work, inventi genius, patriotism of the personnel, a the American habit of refusing to ta "No" for an answer. It is one illu tration of how the United States ou produced the Axis in one short year.

Our primary job was to find a suitabl technical supervisor for the propos depot. We went to the Continental en gine factory, to Lycoming, and to othe engine manufacturers, looking for a man We sent offers to every outstandin engine mechanic whom we knew. Bu the Army, Navy, and manufacturers ha frozen the services of most of the me that we contacted.

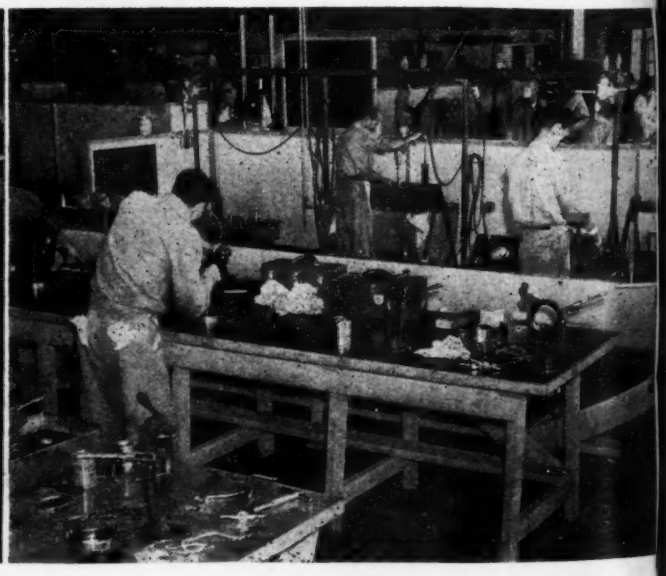
While contract negotiations were go ing on, we learned of a marine engin shop, right in Miami, whose work ha been curtailed because of the war, an here we located Charles Grafflin, whos background included valuable experi ence with both marine and aviation en gines. With this firm reducing its per sonnel, we were able to secure Mr Grafflin and a group of men who ha been associated with him for a number o years, including Bill Ehne, Jack Hale Joe Henry, Sam Heaton, Warren San chez, and Sherman Criehfield, all o whom are now holding responsible posi tions at Embry-Riddle.

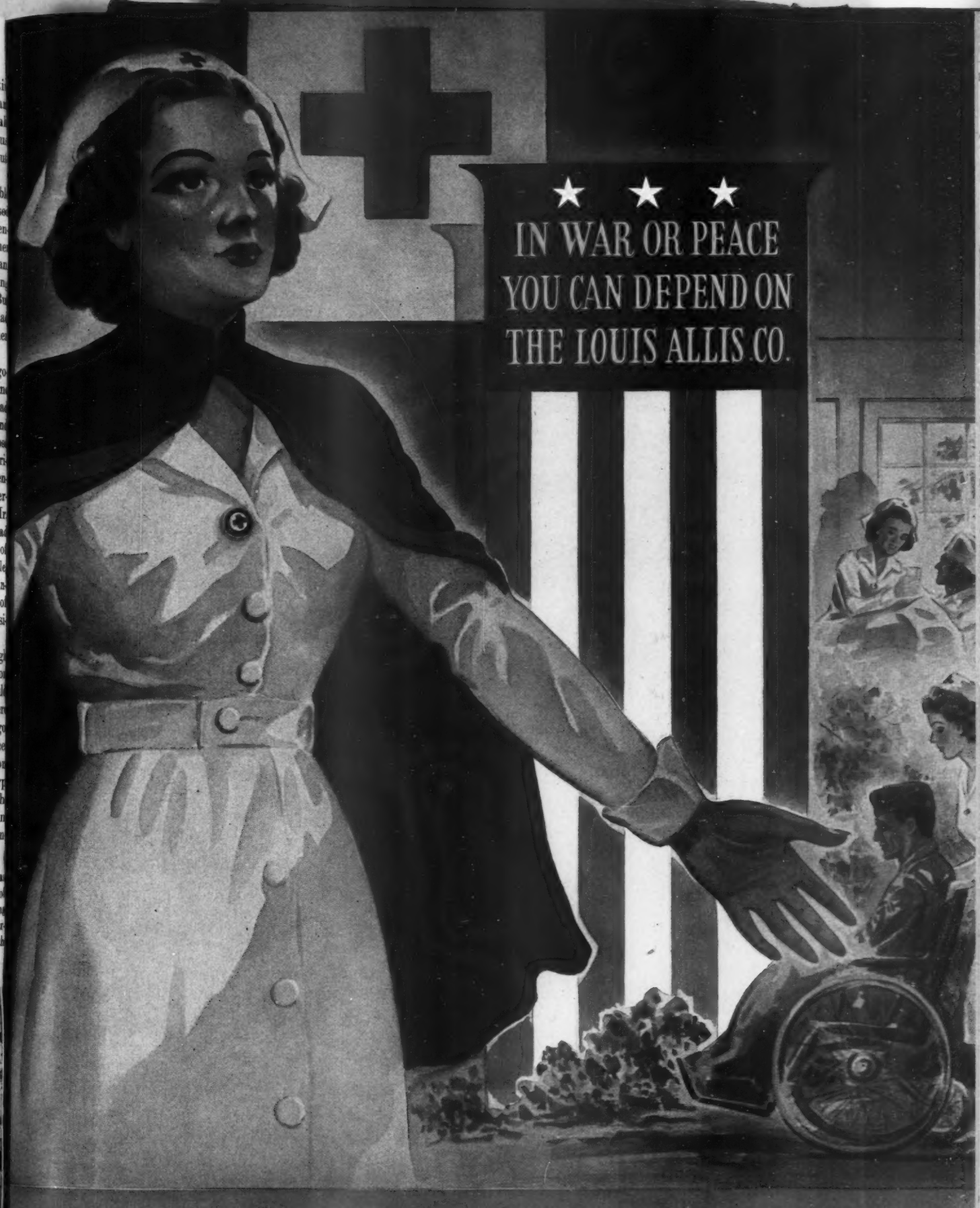
This nucleus first had to go throug a training period for familiarizatio with the type of engines they woul handle. Mr. Grafflin and his crew wer sent to the Magnaflux Corp., in Chicag to learn the latest details and practice connected with magnetic inspection Then at the Continental Motor Corp factory in Michigan, the men studied th fabrication and assembly of the Con tinental training engine. And from Con

**In many cases** improvised equipment wa more suitable than ready-made. Built o angle iron and plate, this cylinder-honin stand is adjustable in three positions, per mits honing of cylinder and refacing of both valve seats without removal.



**Part of machine shop.** Much of station's equipment was made under direction of Author Horton and his associates when manufacturers could not fill orders.



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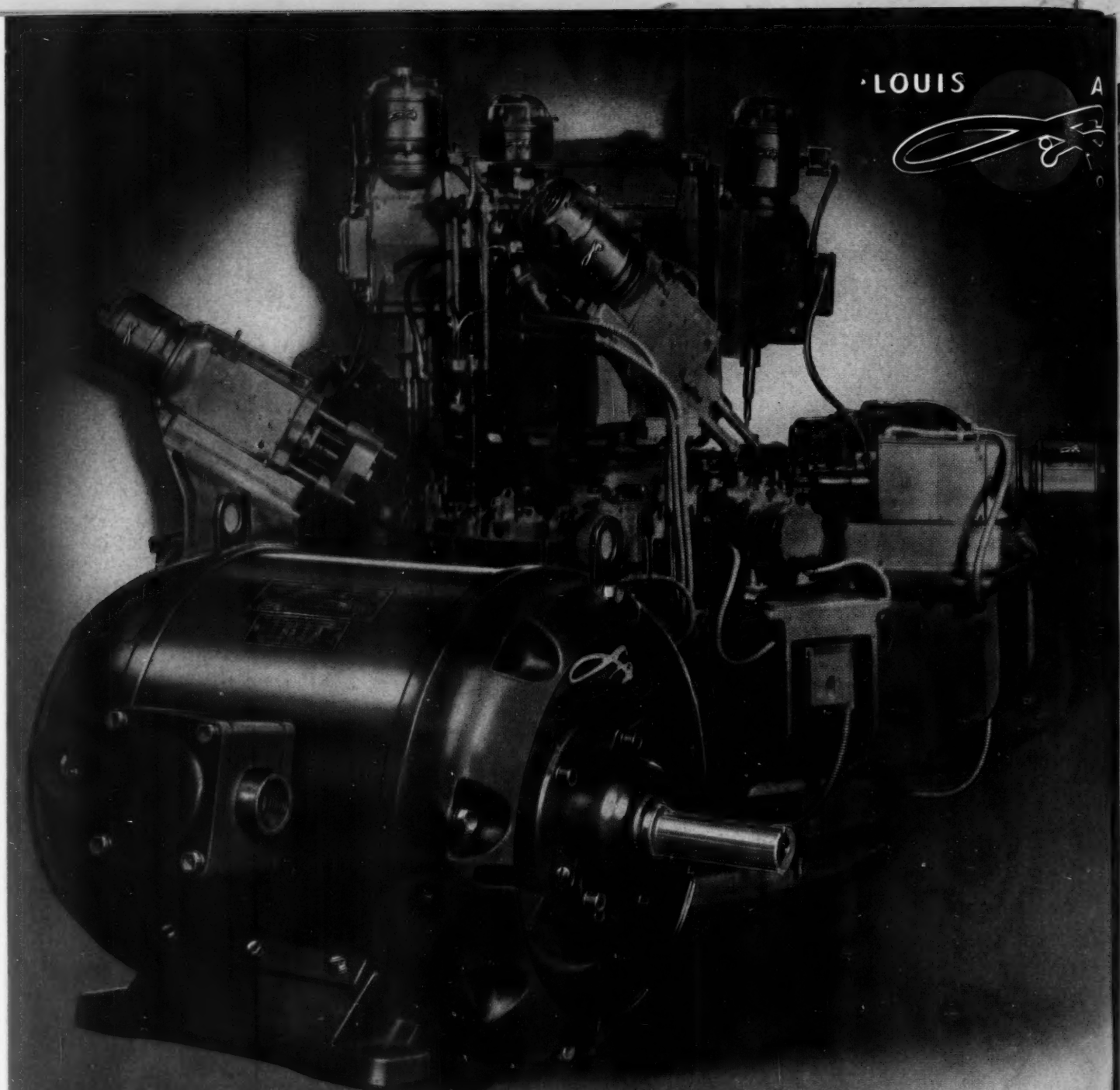
*Your* Moral Help··*Your* Money··*Your* Time··
and *Your* Blood··*not the other fellow's*··YOURS.

THE LOUIS ALLIS CO., MILWAUKEE, WIS.

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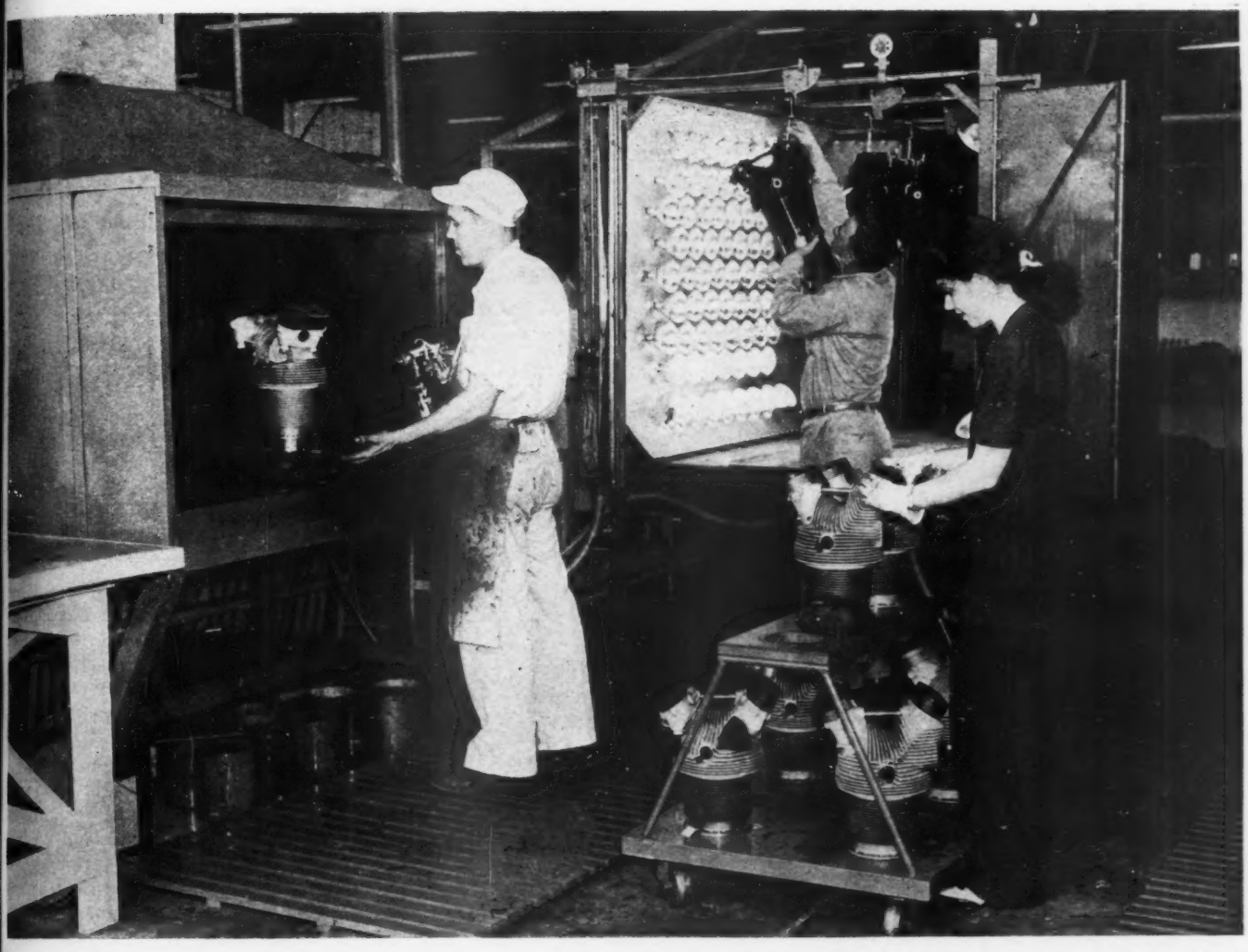
*The motor illustrated is our TOTALLY ENCLOSED FAN COOLED Dust Proof motor — which is available in a wide range of electrical and mechanical modifications.*

**THE LOUIS ALLIS CO., MILWAUKEE, WISCONSIN**



**This infra-red drying oven,** designed and built at the station, makes it possible to assemble cylinders and crankcases within 30 min. of painting.

tinental, they moved on to various Army and Navy overhaul depots in order to get the full benefit of "on the spot" experience in military procedures and methods necessary to engine overhaul.

While the group was spending its time in school being "re-educated," we were busy in Miami preparing to set up our overhaul facilities.

Then we hit another stone wall. We had placed orders with various manufacturers for the necessary equipment, and now the replies began to come in. In the majority of cases, communications read: "We exceedingly regret that we will be unable to fill your order."

There were only two answers. Either the whole project would have to be abandoned, or we would have to become

(*Turn to page* 363)

**Men employed** on final assembly line are under direction of Charles Pelton, who draws on wide former experience as automobile mechanic and garage owner to keep daily output precisely on schedule.

**Doing their** own manufacturing, men contributed this prony brake stand for testing inertia starters.

# How Heaters are Made For American's Flagships

**Some original methods and tools for bending and welding of steel tubing are shown at work in the manufacture of the airline's flash-tube boiler.**

**Fig. 1. Tube bending jig** being operated by its designer, Martin Bulger. Center clamp holds block placed at proper point to bring center of curve at mid-point of tube. Grooved block, which anchors one end of tube, is just behind Mr. Bulger's left hand. All photos by AA.

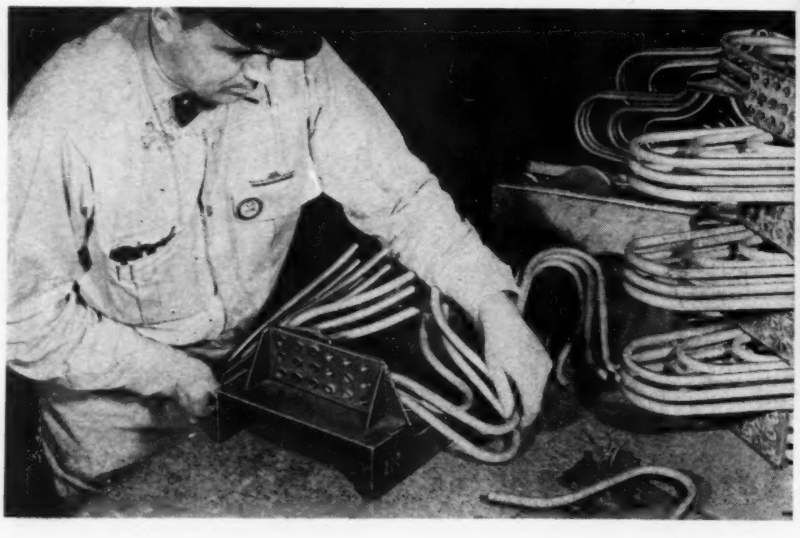
AN INGENIOUS PROCESS of construction stands behind the airplane boilers designed by American Airlines' engineers. Responsible for its manufacture is Weld Shop Foreman Martin "Tiny" Bulger, who is a Lincoln Foundation award winner.

As can be seen in the background of Fig. 1, each boiler consists of three different sized loops of tubing of three rows each, extending in opposite directions, making a total of 18 pieces of tube, whose ends are are welded into two drilled header plates.

To follow the process from the beginning, we start with straight sections of stainless steel tubing which come cut in standard lengths of 16, 18, and 25 in. It is necessary that it be supplied in short lengths because every piece must be inspected for die marks on the inside. Even when very slight, these longitudinal lines will cause the tube to split after 25 to 50 hr. of service at the high temperatures to which it is subjected.

**Fig. 2. Jig for making reverse curves.** Three sizes of "U" sections are accommodated, with locating pins for bending lever and grooved wheel. Tubing is so enclosed that it cannot flatten.

**Fig. 3. Cutting jig,** designed for abrasive circular cut power saw, cutting at proper length and angle so that tube ends will fit flush with surface of end plate. Three sizes accommodated.



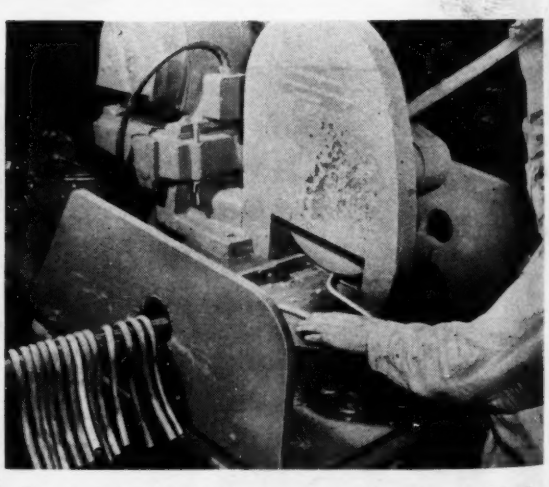


**Fig. 4. Assembly jig** in two extensible sections. Header plates are grooved in ends and sides to receive the shell of finished assembly, made use of here to fix in the jig. Note different sizes of bending wheels in the box.

**Fig. 5. Welding the ends.** Fixture prevents buckling of plate as well as holding assembly. It is made in two longitudinal sections with male pins and female receivers, held together by clamp. Note center support, directly over head of clamp, putting strain on plate opposite to weld strain. Cooling straightens header plate when jig is removed.

**Fig. 6. Testing for leaks.** Both ends are sealed by boxes and rubber pads. Top test plate consists of a box with an air connection allowing entry of air to tubes.

**Fig. 7. Welding flange and collar** for steam connection. Electric arc welding is used throughout, with Stainweld 5A rods.

**Fig. 8. Sump with flange** is welded to end plate. Steam connection is at top, water inlet at bottom.

The straight sections must be bent to three different curves, which is efficiently done in a tube bending jig of Bulger's design (shown in Figs. 1 and 2). It is made up of changeable parts which fit in various combinations to a drilled and slotted bed plate. Two detachable handles bolt at one of several centers through three sizes of "pulley" wheel. These provide the three radii of curve, and are grooved exactly to fit the tube. A straight mating section, which rolls on a bolt through a bearing, bends the tubing about the center as the handle is swung around. The tubing is com-

(*Turn to page* 394)

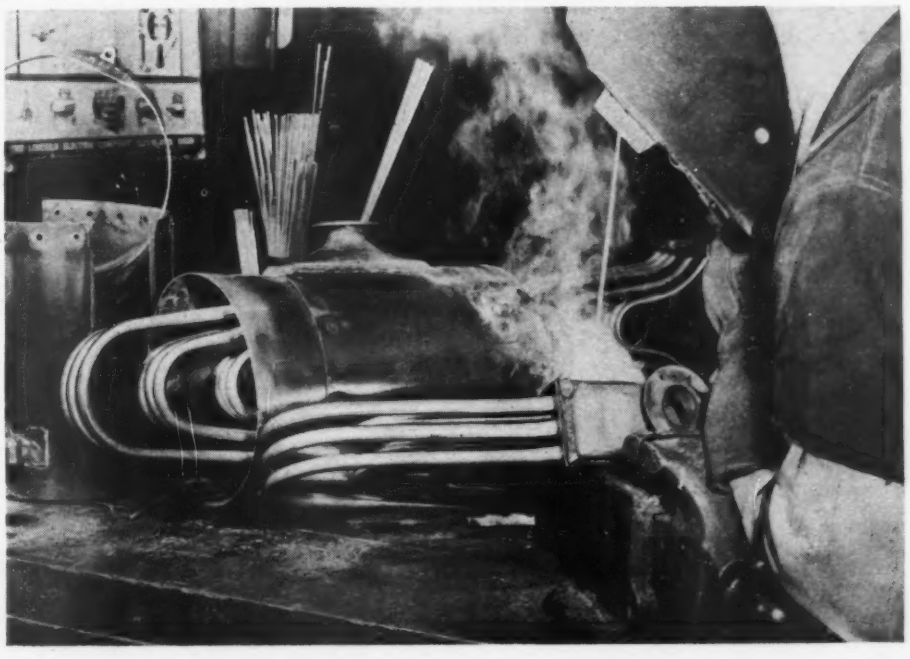


**Fig. 9. Flange and collar** have been welded to sump which is composed of a metal stamping. Sump is being welded to end plate. Shell sections appear at left, finished boiler at center.

# WORTHINGTON
## AIRFIELD
# "GRASS BLITZER"

**Keeps Airfields in Condition to "Keep 'em Flying"**

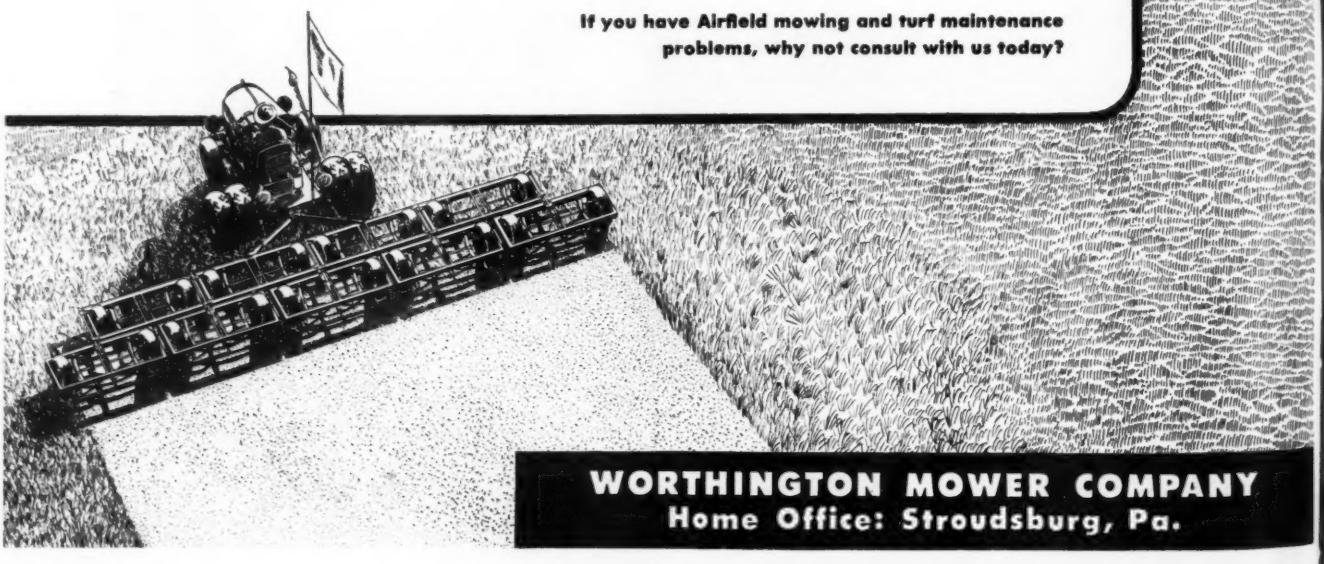
Experts advise at least 10-15 cuttings a season (depending upon location and weather) are required for development of the best turf conditions, and this is important because thick, dense turf:

1. *Keeps down dust which is a cause of too frequent plane motor tear-downs and parts replacements.*
2. *Absorbs rainfall, preventing muddy areas and the danger of serious skids.*
3. *Helps eliminate hazards of loose stone, gravel, etc., injuring propellers during motor revups, take-offs and landings.*
4. *Helps eliminate wheel marks which can be photographed from as high as 30,000 feet.*

Worthington was the first to study the new problem of turf cutting on the vast Airfield acreage and has developed the largest capacity turf cutting apparatus for this purpose.

A tractor pulling a 9-gang Mower cutting a swath 21.2 feet at a speed of 15 miles an hour will cut 35 acres per hour — a grass cutting capacity over three times greater than any other make of tractor and gang mower combination now available.

**If you have Airfield mowing and turf maintenance problems, why not consult with us today?**

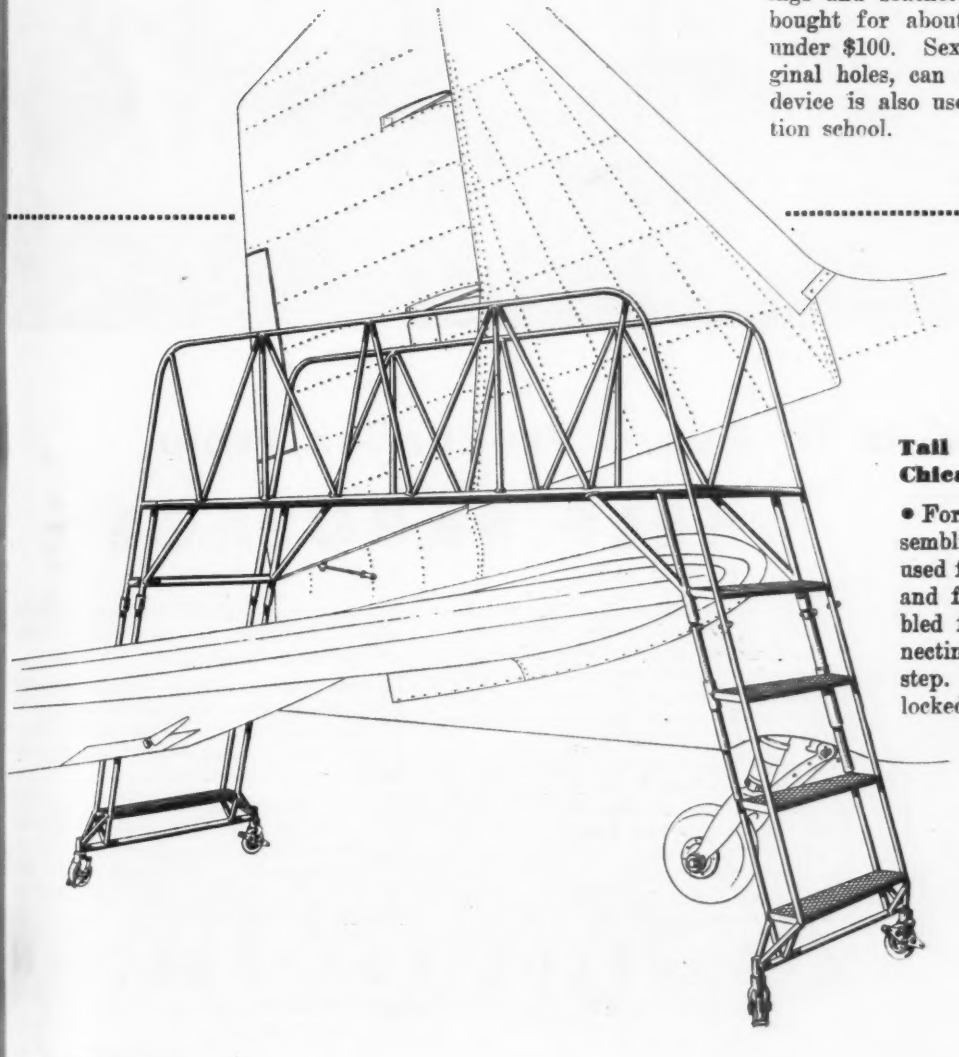


**WORTHINGTON MOWER COMPANY**
**Home Office: Stroudsburg, Pa.**

# AVIATION'S MAINTENANCE NOTEBOOK

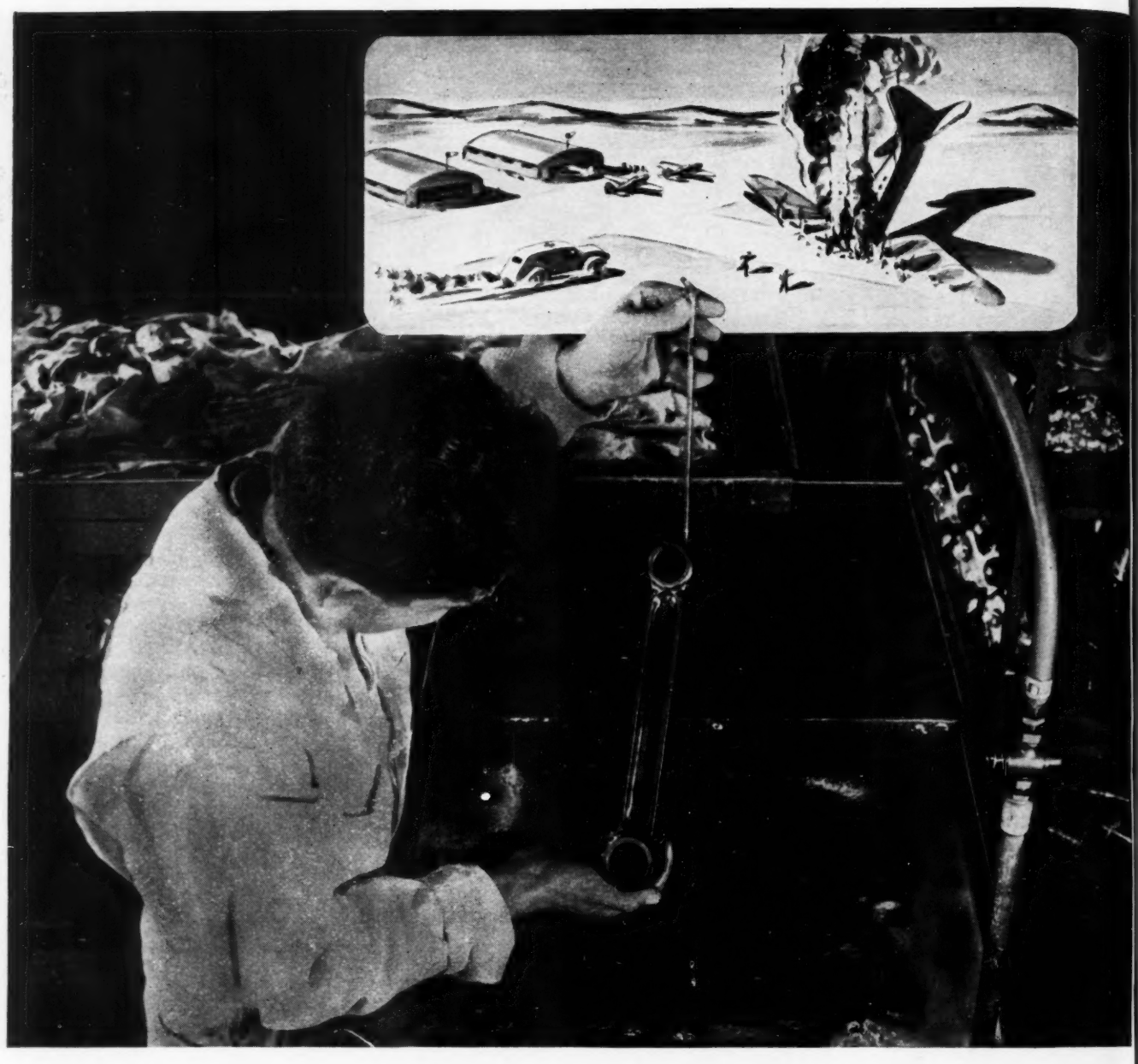
### Octant Collimator at Pan American

• Designed and built by Joseph Potrato, chief of Pan American's New York instrument repair shop, this device used to check and regulate octants is sensitive to a few seconds of arc. Made largely of spare parts, it uses the tube and lens of an old drift meter, has a disk with a pin hole at center placed at infinity point of lens, with a small light bulb in back to furnish sighting "star". Tube is mounted on a bearing giving any angle of elevation from 0 to more than 45 deg., with surveyor's spirit level on top to check for 0. Quadrant and vernier adjustment of a spare sextant are bolted to side of tube, with another smaller surveyor's spirit level for setting at the horizontal. With tube at any given angle, reading of octant taken by sighting through tube at "star" is checked against reading on master sextant. Bearings and bracket had to be made and levels were bought for about $20 each, total cost being well under $100. Sextant parts are bolted through original holes, can still be assembled and used. This device is also used to illustrate examples in avigation school.



### Tail Inspection Stand
### Chicago & Southern

• For inspection of DC-3 tail assemblies, this stand can also be used for work on wing leading edge and fuselage. It can be disassembled for easy shipment by disconnecting the legs just below fourth step. When in position it can be locked by brakes on casters.



# Our Field Is To Guard Production From

# SELF SABOTAGE

**MAGNAFLUX SERVICE**

As originators and pioneers of the Magnaflux methods, Magnaflux Corporation and its engineering staff have accumulated an unequalled fund of specialized knowledge and experience on this subject. This is placed at the disposal of industry in the service which is extended to Magnaflux users. Included are: training for operators, all necessary text books, regular contacts by field engineers, laboratory services, etc.

MAGNAFLUX CORPORATION

In the tense struggle for volume production, the completed plane, tank or machine can be effectively sabotaged by one uninspected and defective part. At that moment, which can occur disastrously in the heat of battle, production defeats itself.

Magnaflux Corporation, originators of inspection methods to indicate probable points of failure before assembly, recognizes this as a broad field of research. In addition to magnetic particle indications by basic Magnaflux methods, many refinements of technique and equipment have been developed. The recently announced Magnaglo fluorescent material which heightens the visibility of indications is an outstanding example.

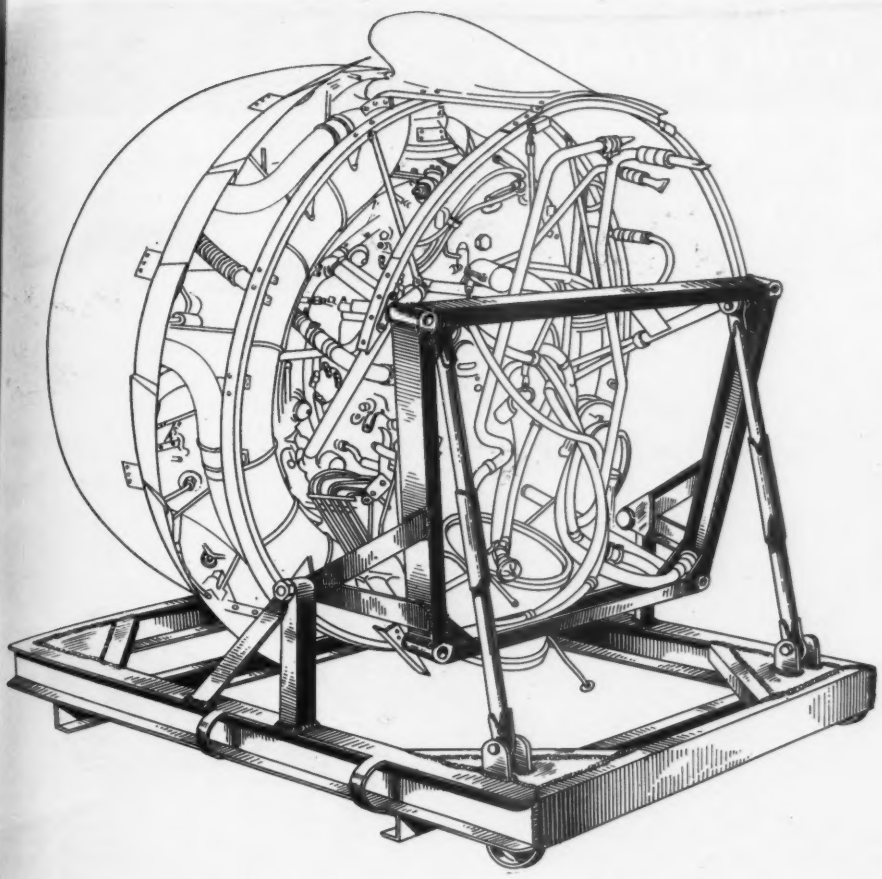
By constant exploration of their selected field Magnaflux engineers recently added, in Zyglo, a method for revealing surface discontinuities on non-magnetic metals, plastics and ceramics.

Your company will find in Magnaflux Corporation, more than a manufacturing and service organization—a solidly-grounded research staff seeking the fullest benefits within the field of production line inspection.

## MAGNAFLUX CORPORATION

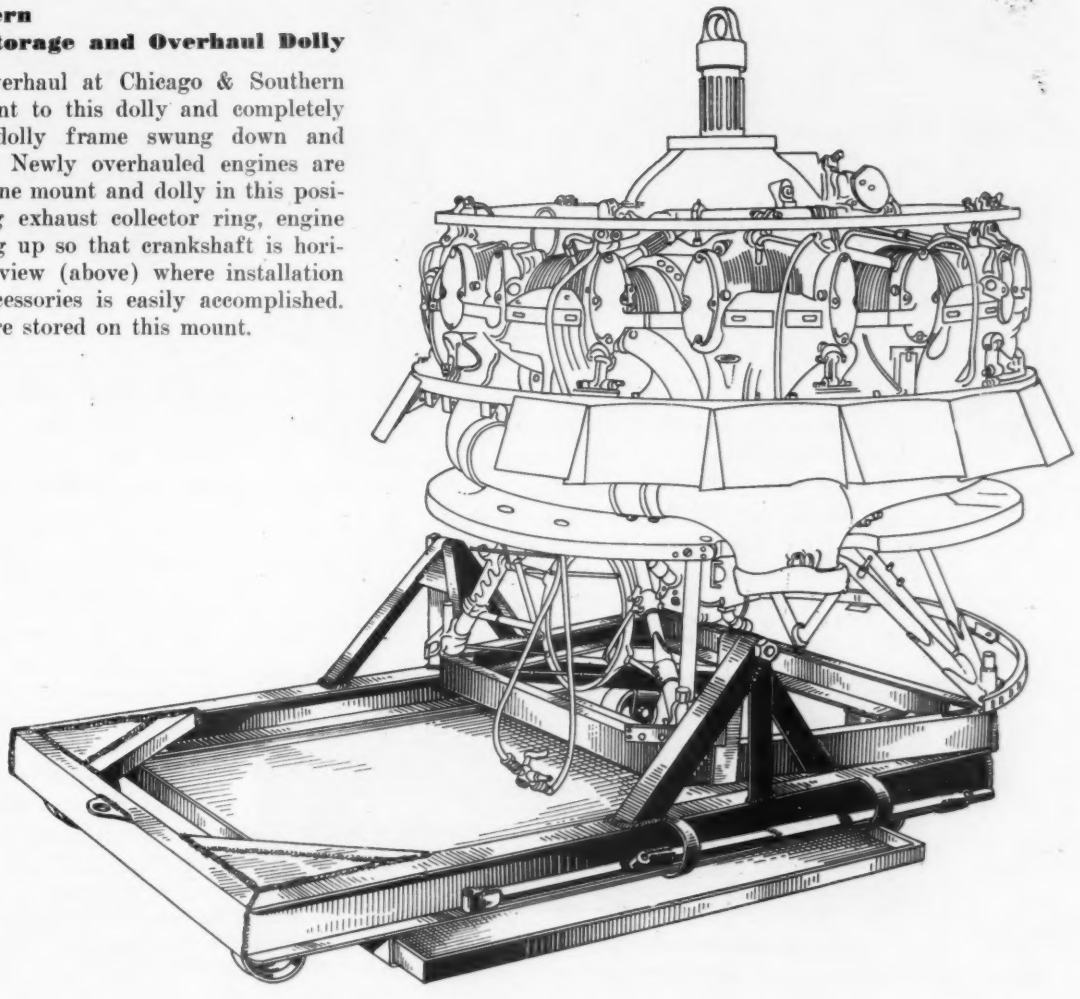
**5908 Northwest Highway, Chicago**

NEW YORK · DETROIT · LOS ANGELES · DALLAS



**Chicago & Southern**
**Engine Nacelle Storage and Overhaul Dolly**

• Engines in for overhaul at Chicago & Southern are bolted with mount to this dolly and completely disassembled, with dolly frame swung down and crankshaft vertical. Newly overhauled engines are also installed on engine mount and dolly in this position. After securing exhaust collector ring, engine and mount are swung up so that crankshaft is horizontal, as in second view (above) where installation of plumbing and accessories is easily accomplished. Completed engines are stored on this mount.



## *They're flying with it today . . .*

# The elliptical oil cooler "that couldn't be built"

An elliptical-shape oil cooler would provide greater freedom in designing. Space could be saved . . . weight cut . . . cooling efficiency increased!

Such advantages have long been known and hoped for. BUT — oil coolers must withstand terrific pressure, and it was thought elliptical construction couldn't take it.

AiResearch engineers, continually at work on the "impossible," tackled this problem. To lick it, they developed a special method of pressure-stressing . . . put the new oil cooler through scores of tests.

And could it take it! Passing the final, rigid Army 50,000 cycle steam test, the AiResearch design met all structural requirements.

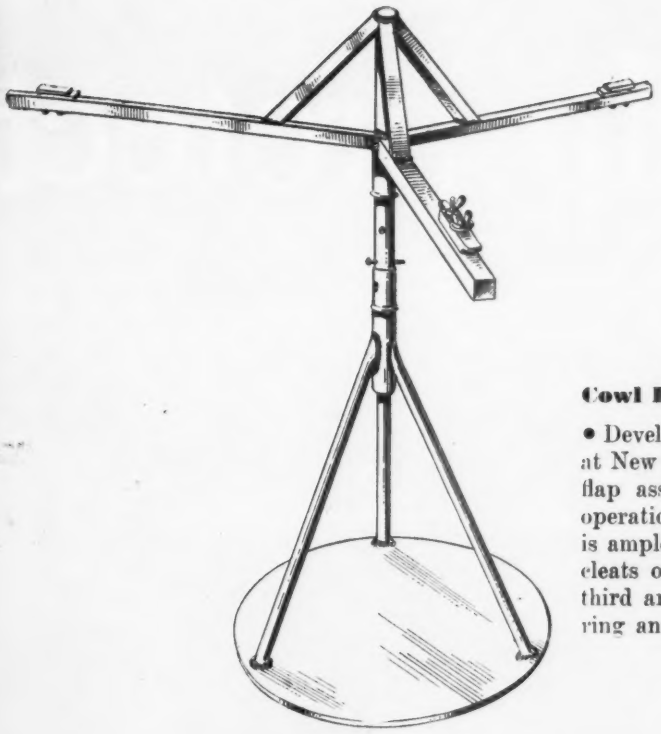
Result: the oil cooler "that couldn't be built" is now in volume production. Today America's warplanes fly with AiResearch Elliptical Oil Coolers.

This new design makes possible the installation of oil coolers in more convenient places. Eliminates waste space. Provides greater cooling efficiency. Only one valve and oil line is needed — simplifying installation, saving weight.

AiResearch Elliptical Oil Coolers are offered to all U.S. aircraft manufacturers. A number of sizes are available. If you are working on new designs, inquiries are invited.

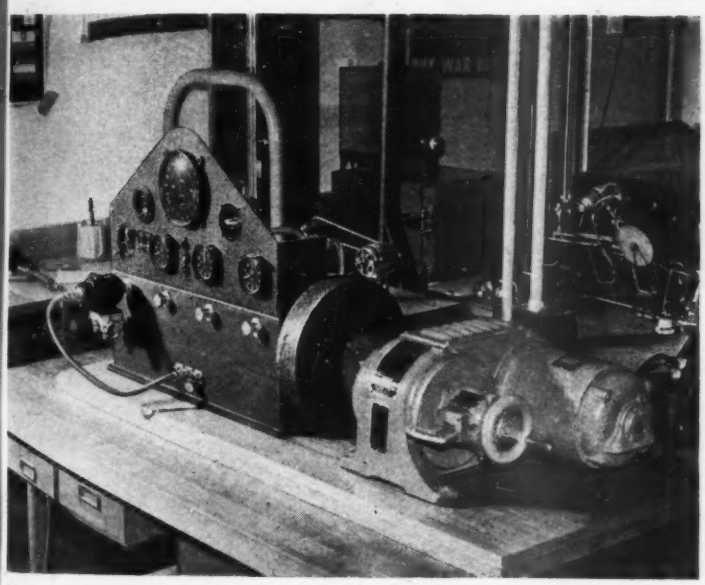
AiResearch
MANUFACTURING COMPANY
LOS ANGELES · PHOENIX
DIVISION OF THE GARRETT CORPORATION

***"Where Controlled Air Does the Job"*** · Automatic Exit Flap Control Systems
Engine Coolant Systems · Supercharger Aftercooling Systems · Engine Air Intercooling Systems



### Cowl Flap Stand in PAA Shop

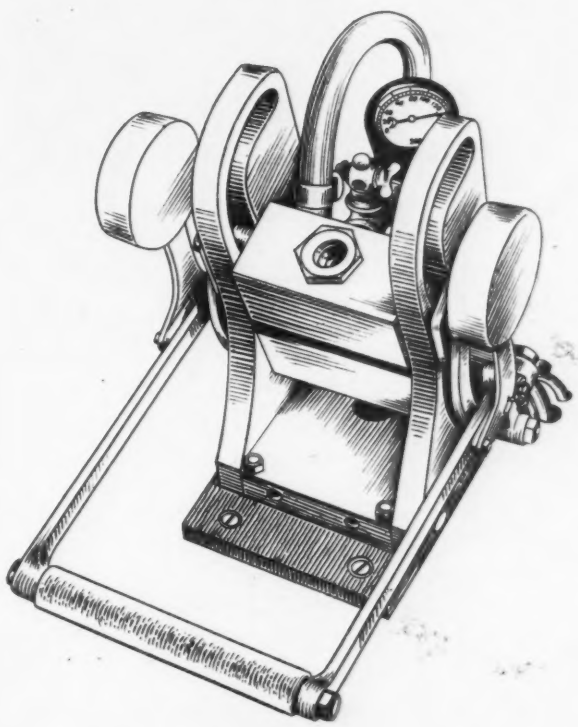
• Developed by A. P. Peria, chief of engine overhaul at New York, this simple tripod stand supports cowl flap assembly in horizontal position, allowing full operation of flaps for repair and inspection. There is ample space inside for workmen to stand. Notched cleats on two arms hold assembly. Sliding cleat on third arm is pushed out against inside of cowl flap ring and set to hold with wing nuts.



### Master Tachometer Test Stand at TWA

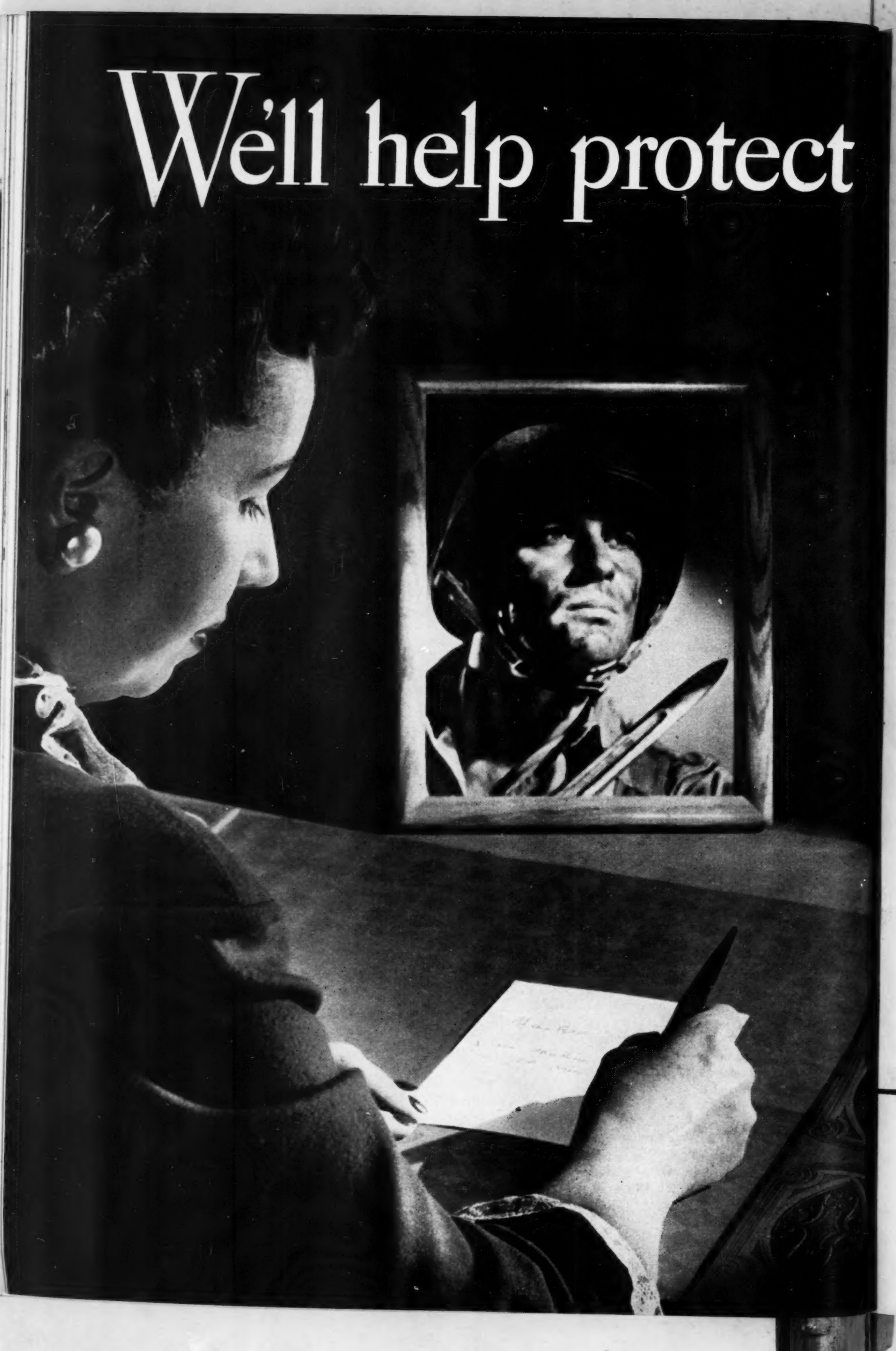
• For testing as many as four tachometer generators and indicators at the same time, TWA has assembled this unit, consisting of a variable speed drive motor coupled to a manifold with several outlets, a stroboscope, master tachometer and generator, and four receivers for units to be tested. Operation is as follows: Drive motor is set at desired speed, registered by master indicator. Stroboscope housed in drum is then cut in, guided by approximate speed indicator in front of regulator handle. When on speed desired, stroboscope indicates rpm. within plus or minus 1, so that units under test can be set to an exact and infallible standard. Tachometer generators are plugged in, as shown, on front of panel, with indicators above. Master dial is at top. Direction of rotation of unit can be reversed, as well as indication of master tachometer, so that all types of tachometers can be handled. Also included is an a.c. voltmeter and selector switch to check the delta voltages of the a.c. generators under test. TWA reports considerable time saved in overhaul.

### Spark Plug Tester In United Shops



• This device, designed and built by United Air Lines, tests spark plugs under pressure. When handle is raised, assisted by counterweights, a plug is set in the center chamber, which has an electric terminal. With handle firmly closed, air pressure up to 150 psi. is applied, as shown on gage. Current from an aircraft magneto operating at about 1,900 rpm. fires the spark plug, which must operate continuously for a full minute to be approved.

# We'll help protect



# him, Mrs. Smith!

## —but we'll need the full cooperation of every steel fabricating plant to do it

*Mrs. Smith—or maybe you're Mrs. Kelly or Cohen or Jankowsky—it makes no difference, because each of you has a boy in the armed forces of our country.*

*Is he on Guadalcanal, in North Africa, in Australia, in Iceland, Mrs. Smith? That's where our boys are, too. You see, thousands have gone from the mills, mines and offices of the steel industry (more than 13,000 from Republic alone). Thousands more in service are sons or brothers of steel workers.*

*So maybe your boy, in a sense, is our boy. But does it matter? We want all of them to come home victorious—and safe—just as soon as possible.*

*And that, Mrs. Smith, is where we, the steel industry, can help—by furnishing enough of the strong, tough alloy steels needed to produce the best, the safest fighting tools in the world for your boy. But—to do so, WE MUST HAVE THE FULL COOPERATION OF EVERY STEEL FABRICATING PLANT.*

### Fabricators MUST segregate Alloy Steel Scrap—or schedules may COLLAPSE!

Alloy steels cannot be made without nickel, chromium, molybdenum or other critical alloying elements. And such materials are scarce—growing scarcer every day. There just isn't enough to go around now. So what about the future?

Here's what! We must reclaim every possible ounce of alloy from steel scrap.

Every time you machine alloy steels, substantial quantities of alloying elements go into the scrap pile. But unless you keep each lot of alloy steel chips, turnings, shearings and other scrap separate—segregated at the machine and correctly labeled with its grade number (SAE, AISI, NE or other), the maximum value of those alloys may be wasted, even lost.

To charge scrap of unknown alloy content into the furnace may mean possible loss or waste of the alloys—possible ruin of that heat of steel—certainly, disruption of melting schedules. On the other hand, the only way we can determine the alloy content of mixed, unmarked scrap is by melting it down and pouring it into ingots, wasting the time of furnaces and skilled crews which should be producing usable steel.

Chemists and metallurgists must take time to analyze the ingots to determine what and how much alloys they contain. Finally, the scrap ingots must be remelted again when the desired analysis is being produced. That is waste of materials, manpower, time—costly waste.

We know you're busy—that you face many problems—*BUT THIS IS EQUALLY IMPORTANT*—and can be taken care of in a hurry. Just take a few minutes *right now* to issue an order to your plant to segregate alloy steel scrap, *mark* it correctly and return it *promptly*. While you're at it, make some one responsible for checking at least once a week to see that your order is being carried out. You'll help protect Mrs. Smith's son—maybe your own son—and, incidentally, the American System of Free Enterprise which made your business possible.

REPUBLIC STEEL
PRODUCTION FOR VICTORY

*This Advertisement Sponsored by*

**REPUBLIC STEEL CORPORATION**

**Alloy Steel Division Sales Offices: Massillon, Ohio • General Offices: Cleveland, Ohio**

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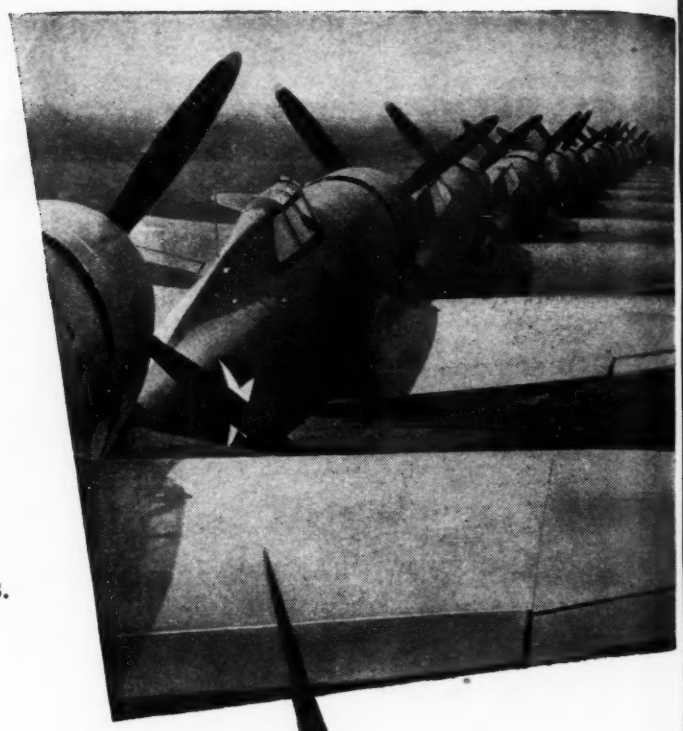
*In Cooperation with the U. S. Government's Salvage Campaign*

**Poster size reprints of this advertisement and wall cards giving official W.P.B. alloy scrap classifications will be sent upon request.**

## MASSED MIGHT • • •

Prodigious in heft and brawn, supreme in speed and punch, squadrons of 2,000-h.p. *Republic P-47 Thunderbolts* excel in sheer destructive power. No altitude is too great, no enemy too fast or too strong, for these stalwart fighting units of the U. S. Army Air Forces.



# REPUBLIC AVIATION

AIR MASTERY THROUGH ENGINEERING EXCELLENCE

REPUBLIC AVIATION CORPORATION — REPUBLIC AVIATION — FARMINGDALE, L. I., NEW YORK

# Designing Gun Turrets as Integral Part of Aircraft

***Part II***

MILITARY

**By L. G. FRISE**

*Chief Engineer to Aircraft and Armament Divisions, Bristol Aeroplane Company*

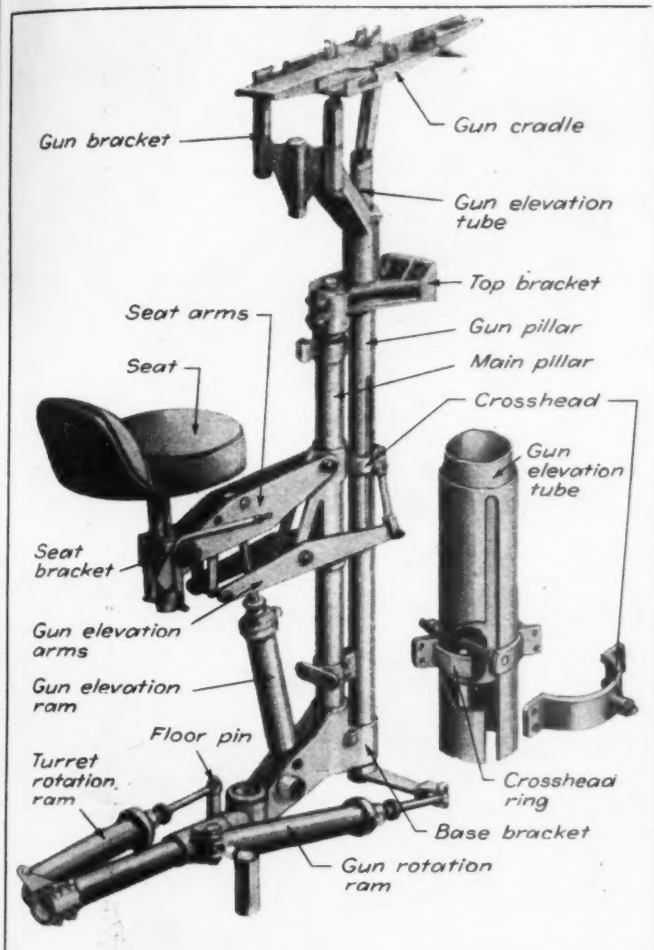



**Fig. 12. A feature unique** in powered gun mounting—a secondary rotation of gun on top of pillar, which itself rotates with turret. By this means, guns do not always point radially from center of ring but may, if mounted in tail, be trained to actually fire directly behind rudder. This feature, first fitted to early *Blenheims* before and during Battle of Britain, contributed largely to their success.

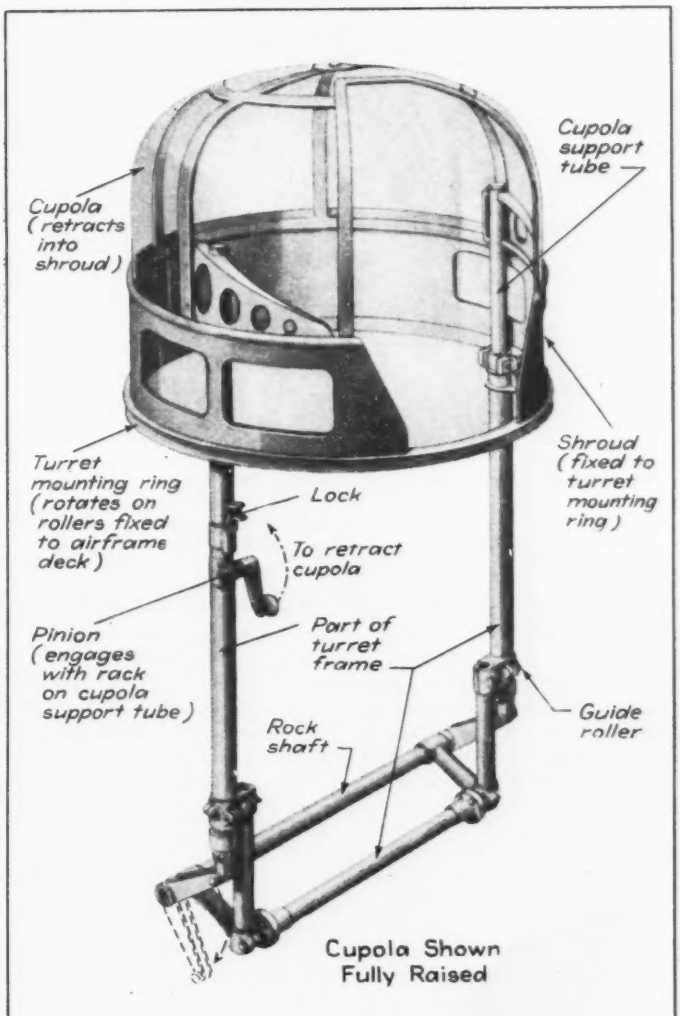

Cupola support tube
Cupola (retracts into shroud)
Shroud (fixed to turret mounting ring)
Turret mounting ring (rotates on rollers fixed to airframe deck)
Lock
To retract cupola
Pinion (engages with rack on cupola support tube)
Part of turret frame
Guide roller
Rock shaft
Cupola Shown Fully Raised

**Fig. 13. First retractable cupola** to be installed on a production aircraft. Reduction of drag thus obtained is valuable contribution to increased range of aircraft. Retraction, although curtailing elevation of guns, still permits useful angle of fire.

**Detailed drawings reveal solution of many problems encountered in later development stages of Bristol power-operated turrets.**

CONTINUOUS RESEARCH at the Bristol Aeroplane Co. has brought the structural weights of its aircraft down among the lowest in the world. And the same holds true with the company's power-operated gun turrets.

This lightness in turrets has been achieved by leaving out, instead of carving out—a vital factor in reducing man-hours required per turret. The simplest engineering methods are used without recourse to precision work.

As a consequence, when large-scale production started it was possible to make use of subcontractors familiar only with general work. Thus, at the critical period when *Blenheim* bombers were smashing at the Nazis' invasion preparations, large production was well ahead without necessity of awaiting the building up of specialized capacity.

Presented herewith are some of the design solutions achieved in power turrets, both prior to and subsequent to that critical period. See figures above and those on following pages.

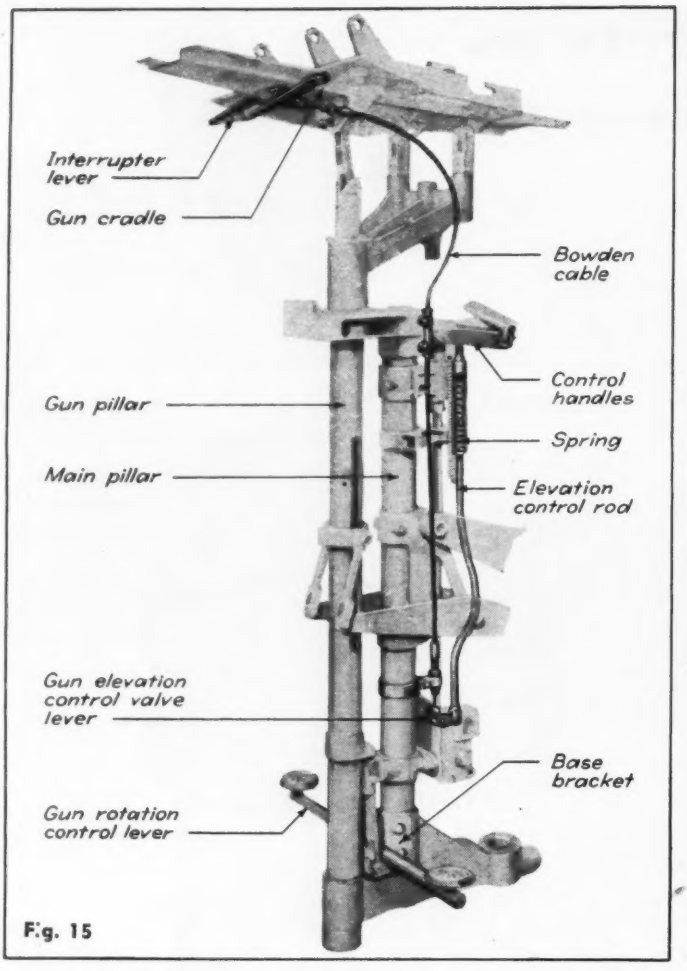



Fig. 15

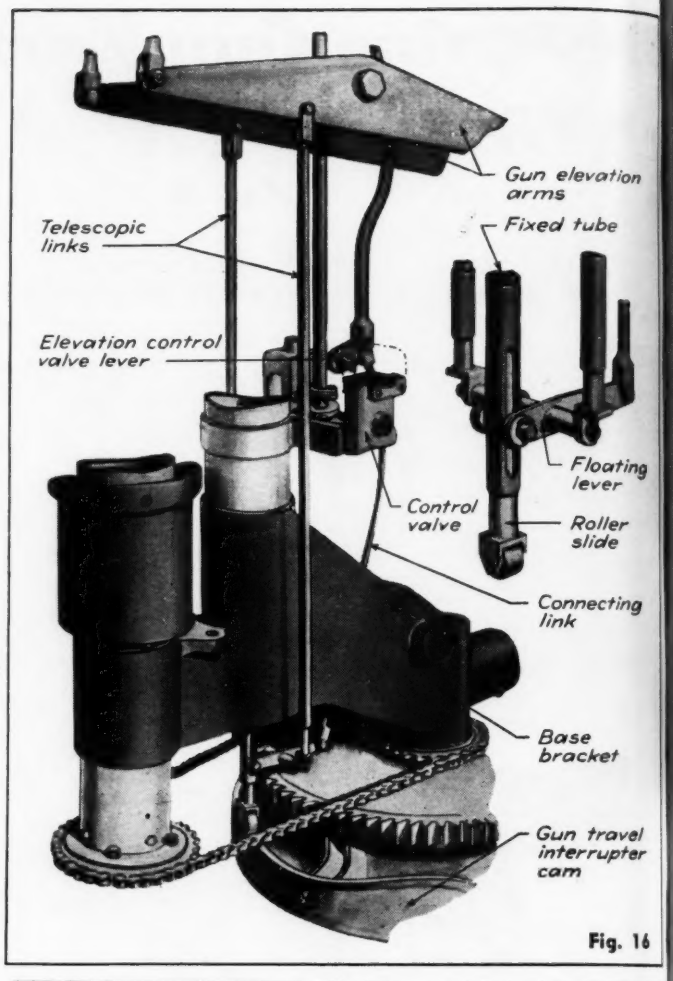



Fig. 16

**Figs. 15, 16 and 17.** Two types of gun interrupter gear are used: A mechanical type to prevent protruding gun barrels from fouling any part of aircraft structure; and electrical firing interrupter to prevent shooting more distant parts of aircraft, such as tail or propeller, that may be in sights. Figs. 15 and 16 illustrate mechanical types, and Fig. 17 the electrical, providing arc of cut-out varying with speed of rotation.

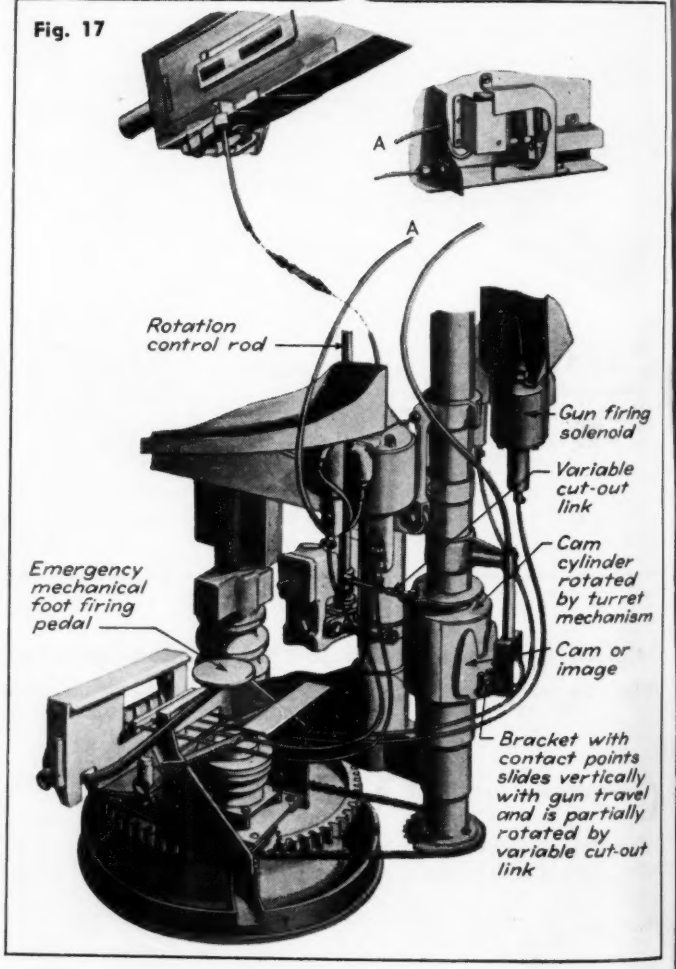
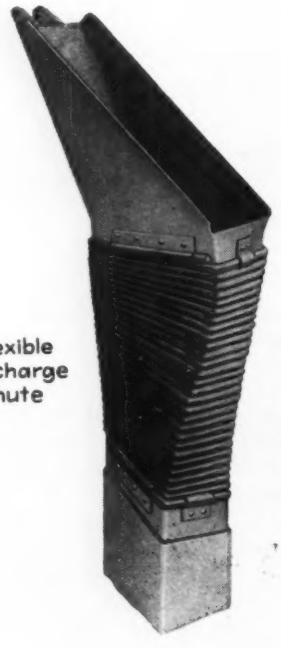


Fig. 17
A
A
Rotation control rod
Gun firing solenoid
Variable cut-out link
Cam cylinder rotated by turret mechanism
Emergency mechanical foot firing pedal
Cam or image
Bracket with contact points slides vertically with gun travel and is partially rotated by variable cut-out link



Flexible Discharge Chute

**Fig. 14.** An interesting detail connected with secondary travel was design of discharge chute for empty cartridge cases having sufficient flexibility, without collapsing, to allow for many degrees of movement.

# Tools for Bombers

IT'S dusk again! Bombers are lined up in front of hangers . . . crews at their stations . . sweetly tuned motors straining for the take-off . . . everything ready for another raid over enemy territory.

Since the return of the previous night's expedition, ground crews have gone over engines, planes and instruments with infinite care. Spark plugs have been cleaned and checked . . . gas and oil lines tightened . . . a nut adjusted here . . . a screw there . . . making sure there can be no possibility of mechanical failure on this most hazardous mission.

10-to-1 BONNEY TOOLS played a leading part in making sure of mechanical perfection . . . helped do it quickly . . . easily. Wrenches and sockets gripped bolts and nuts firmly . . . long, slender handles reached "hard-to-get-at" places with ease . . . screw drivers, pliers, other BONNEY TOOLS all played their part in getting ready for an important job.

With tens of thousands of engines produced by leading aircraft engine manufacturers, BONNEY TOOLS are standard, original equipment . . . selected because their quality has been proved . . because through the years they have earned the reputation "the finest that money can buy". And nothing can be *too* good where the lives of American Fighting Men are at stake.

**BONNEY FORGE & TOOL WORKS, Allentown, Pa.**

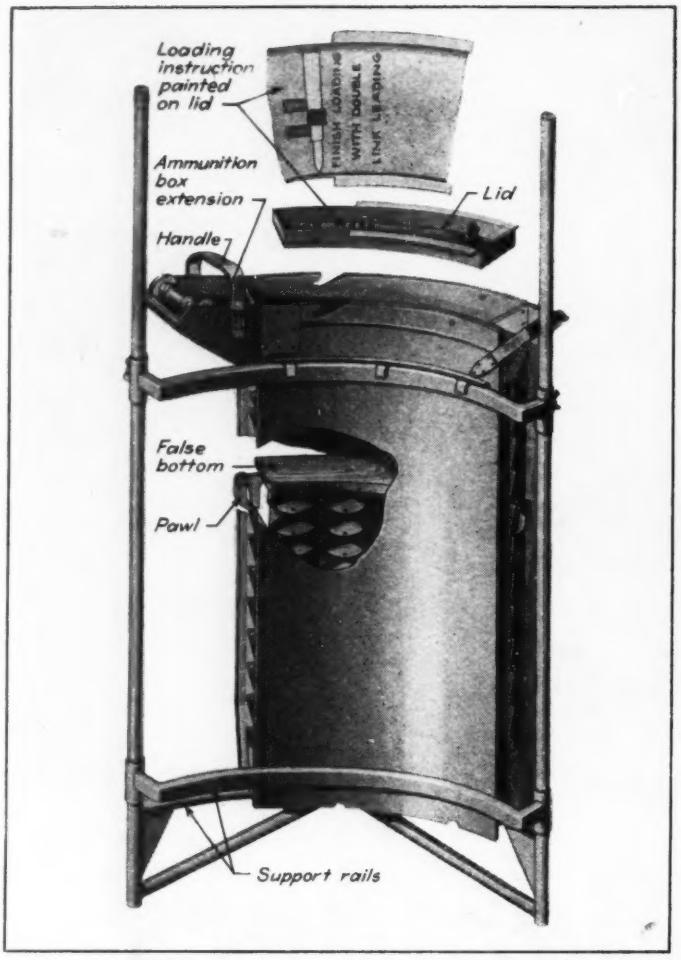



**Fig. 18. Two original ammunition box features** giving greater capacity. First, box is curved to fit radius of rotation, giving greater accommodation fore and aft; second, depth of box can be increased beyond that from which gun can lift ammunition belt by use of collapsible spring bottom which lifts ammunition belt as it is used up so that feeding takes place only from upper surface of box.

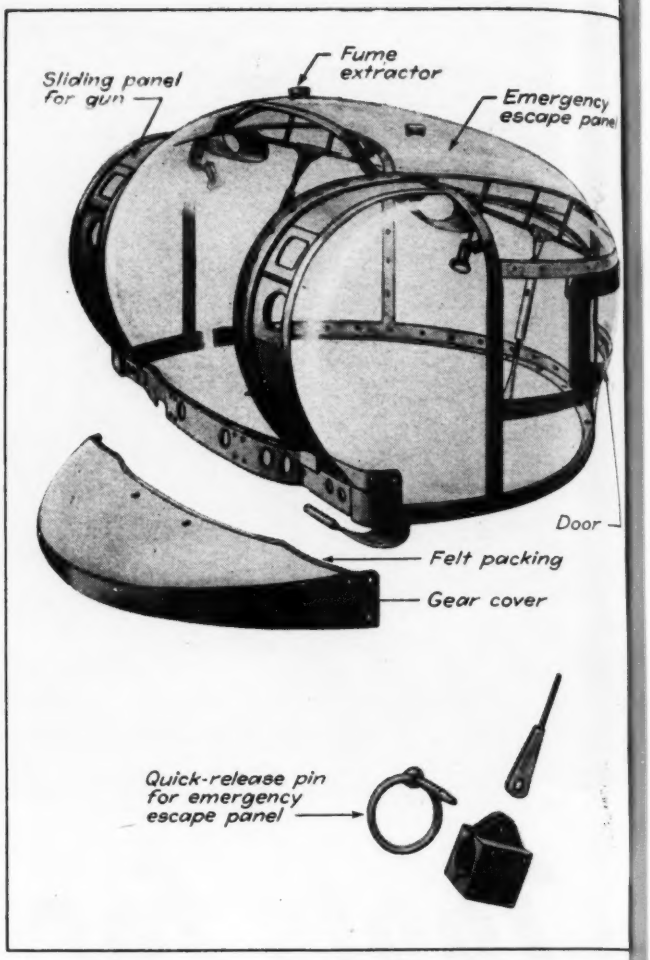



**Fig. 19. Simple method of sealing gun slots** in cupola. The steel strip is anchored at top and bottom of slot, coiling or uncoiling itself as guns move up or down.

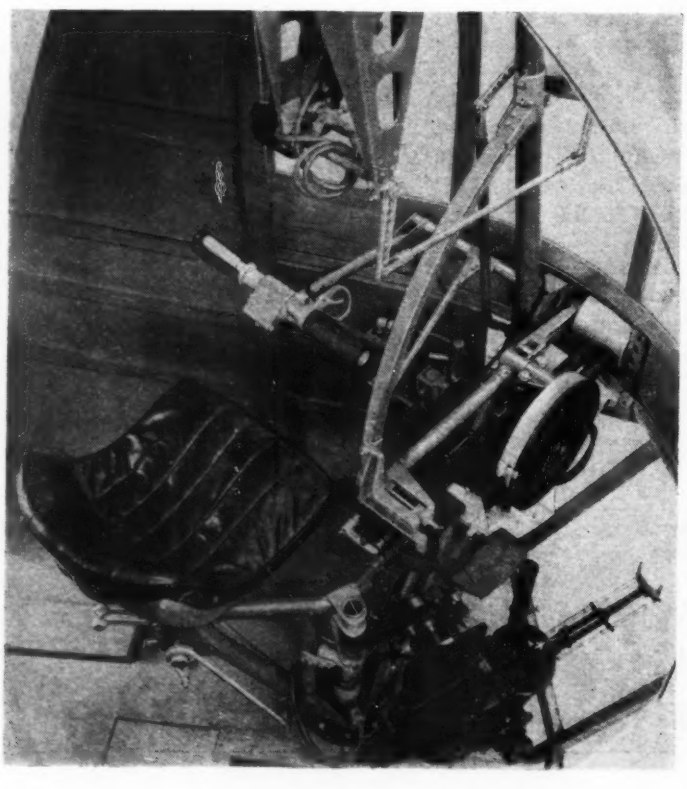


**Fig. 21. Unique method of mounting guns** in nose or tail, while still retaining clear space for bomb aiming or observation unrestricted by normal circular turret construction. It is achieved by use of flexible band (in center between transparent panels) which slides in grooves around sides of nose or tail, thus forming part of skin covering. Guns protrude through flexible band, which moves with them.

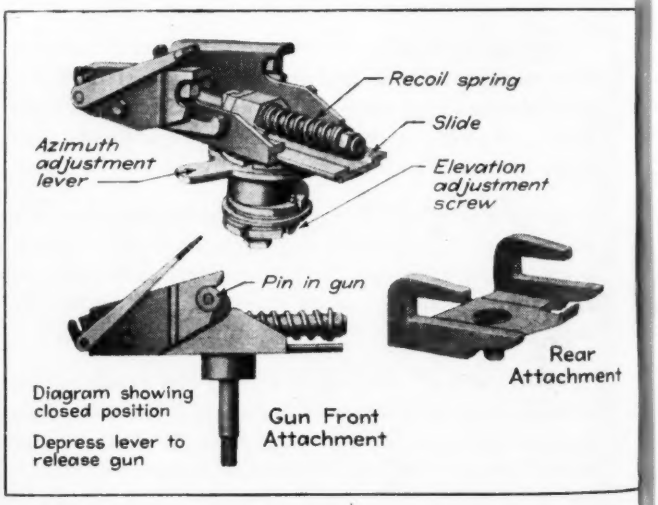



**Fig. 20. Gun mounting detail.** Front attachment provides recoil damping, vernier adjustment for asimuth and elevation, and self-locking grip when gun is pushed in from rear. Gun is instantly released by pressure on lever, which may be remotely actuated in a confined space.

Every one of us at Thomas & Betts was honored recently to receive the Army and Navy "E" Award for outstanding production of War materials.

As a company we are proud to fly the flag. As individuals we are proud to wear and treasure the "E" lapel pins.

We feel an even greater honor. That is, the privilege of making unspectacular but essential electrical fittings for the War machinery used by our fighting men on land and sea and in the air. Our supreme honor is the opportunity to help our armed forces win the War.

And so we cannot rest on our laurels. To us the Army and Navy "E" Award says: "So far, so good; but go farther and do better."

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McQuay-Norris, a pioneer manufacturer of parts in the automotive field, is devoting itself in increasing measure to the aviation industry. Our Aircraft Division projects the McQuay-Norris policy of clinical research into this important field with the result that we are continually adding to available parts, technical assistance and research experience. Your inquiries are invited.

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Pistons for Oxygen Compressor
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Pins for Oxygen Compressor
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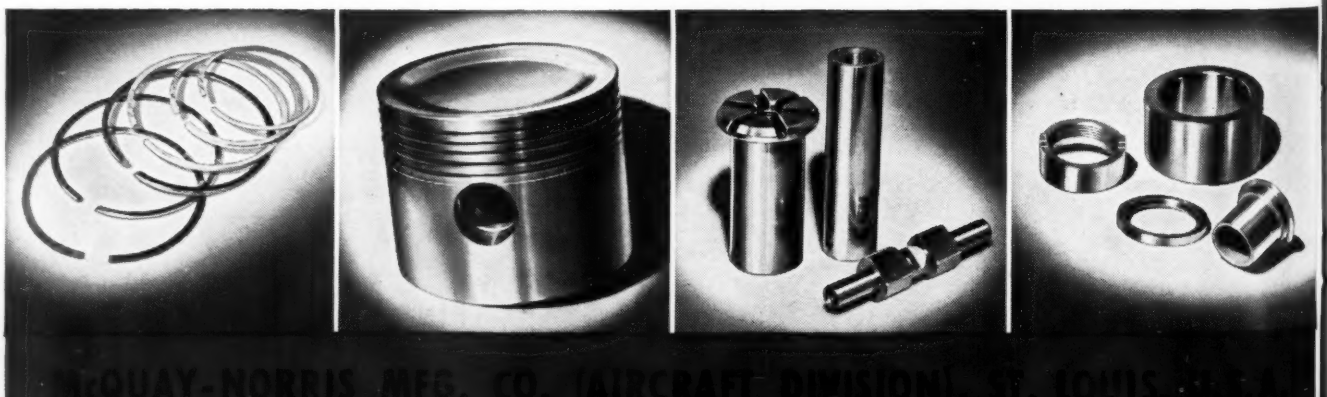


McQUAY-NORRIS MFG. CO. (AIRCRAFT DIVISION), ST. LOUIS, U.S.A.
CANADIAN PLANT, TORONTO, ONTARIO

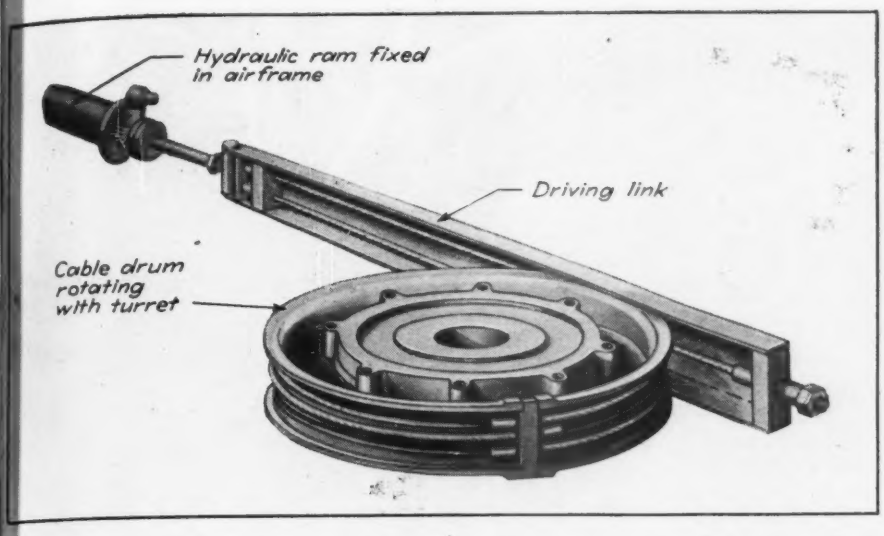


**Fig. 22. Simple means** for transmitting movement of hydraulic ram to give rotation to turret entirely free from backlash.

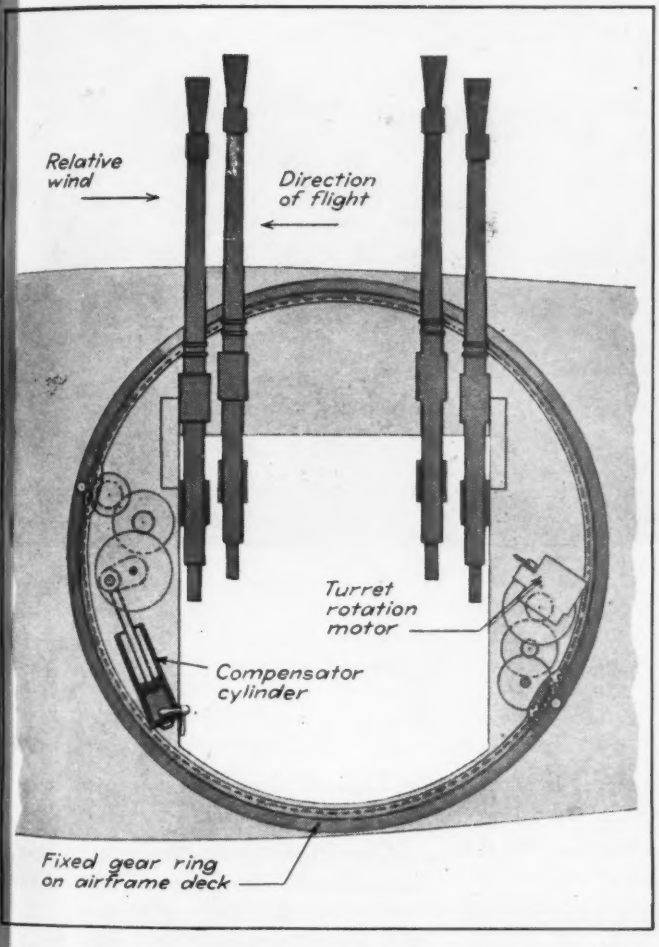



**Fig. 23. Hydraulic compensator** devised to reduce peak loads due to increased torque in moving guns upwind. It is simply geared into driving ring. And ram, being fed with oil pressure from system, applies compensating torque. By this means, power and weight of necessary hydraulic pump and motor can be substantially reduced.

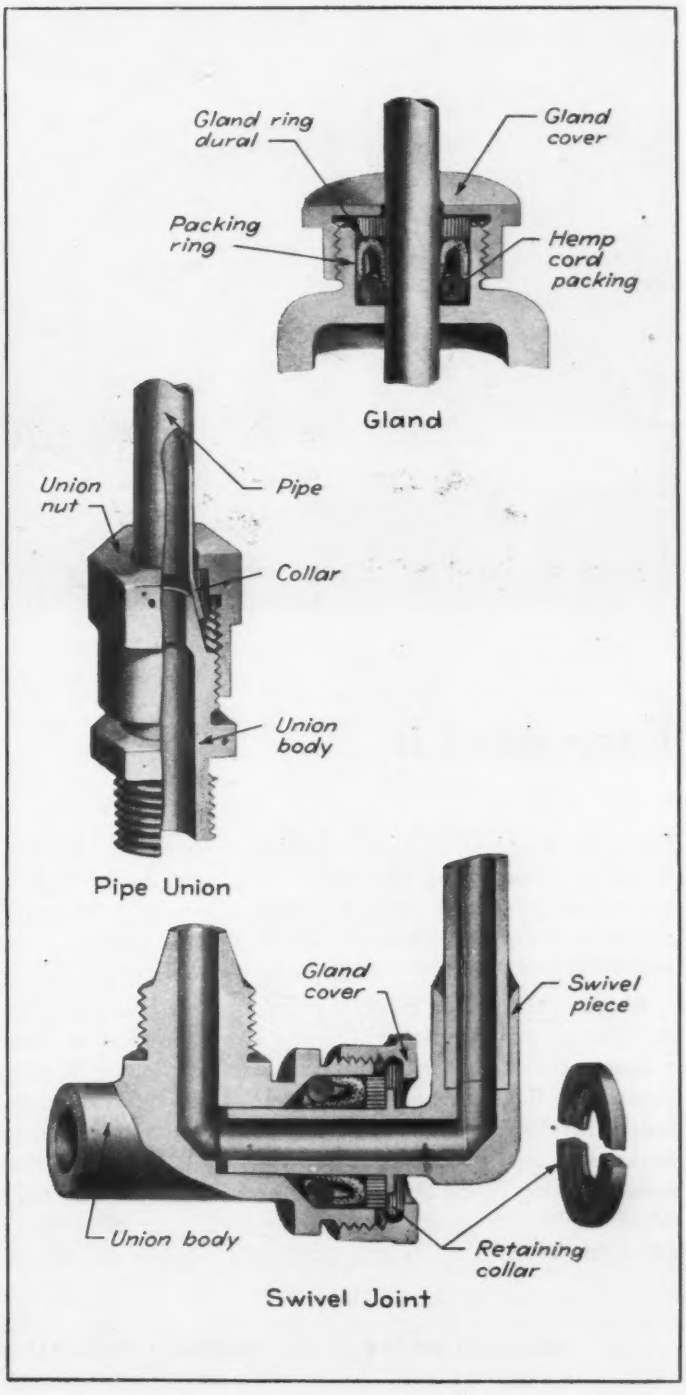
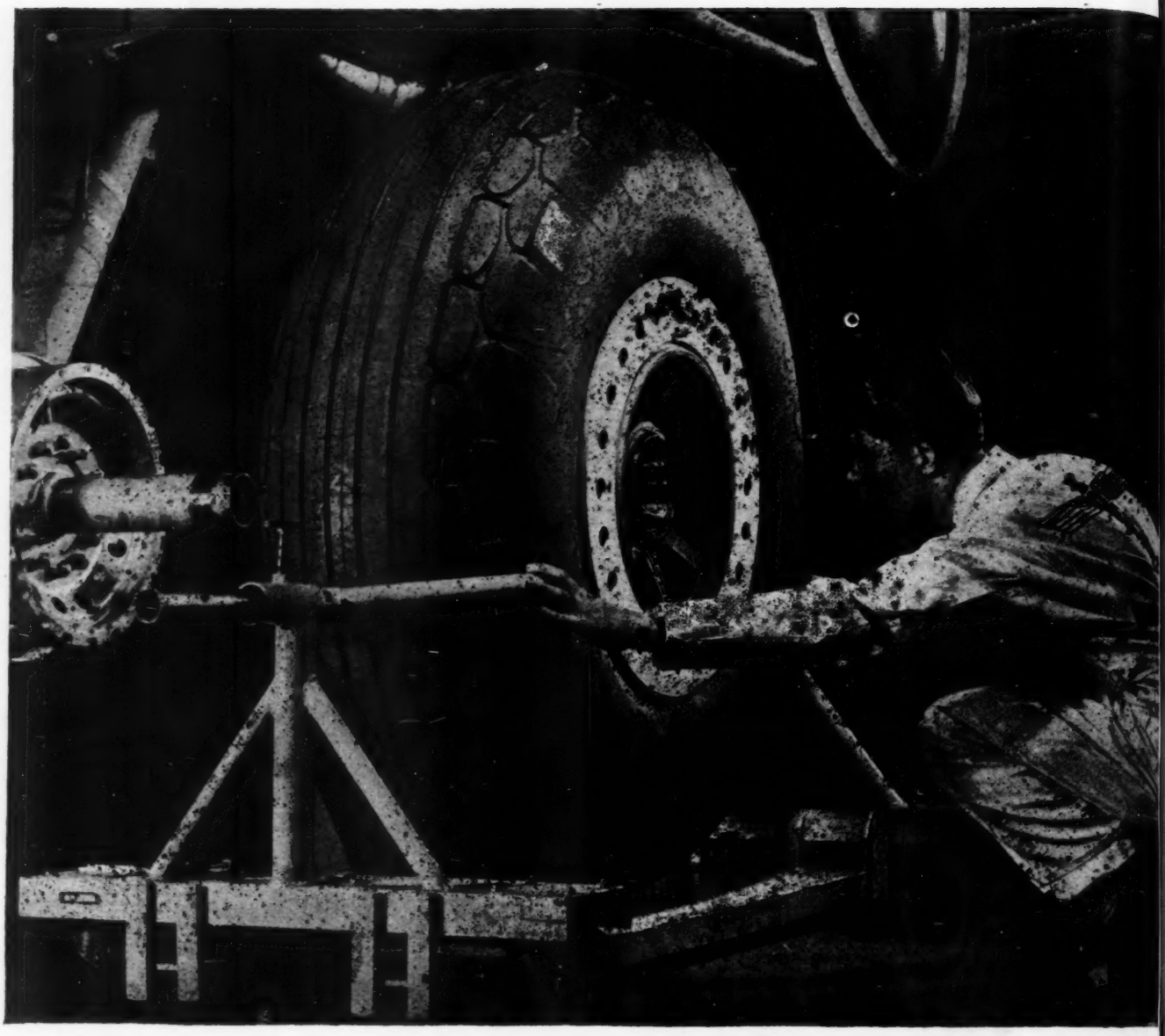



**Fig. 24. Swivel joint** which has found many applications, both on turrets and in general hydraulic systems. Thousands of such units have been used with complete reliability in replacing hose.



# Easy does it

One of the most important jobs at Boeing is making other Boeing jobs easier . . . simplifying procedures so that, despite shortages of skilled workers, production constantly goes upward.

Above is pictured an example of this easy-does-it manufacturing philosophy—a simple device, but it illustrates the point: the Boeing-developed wheel-installation dolly, by means of which *one* worker slips quarter-ton wheels onto the axles of Boeing Flying Fortresses.* The wheel, held firmly on the dolly by adjustable arms, is rolled into position on casters. Once the wheel is slipped over the landing-gear axle, the arms of the dolly are moved back . . . and the job is done.

This is but a simple example, and only one among hundreds, of the constant effort in Boeing plants (at Seattle and Renton, Washington, Wichita, Kansas, and Vancouver, B. C.) to achieve maximum production efficiency with a minimum of human exertion, through improved tools and handling equipment . . . an effort which has contributed to *the highest output per man, machine and unit of plant space,* among all manufacturers of aircraft.

Co-ordinated with Boeing know-how in research, design and more than twenty-five different engineering fields, this manufacturing skill has made Boeing-designed and Boeing-built Flying Fortresses renowned not only for *quality* but for *quantity.*

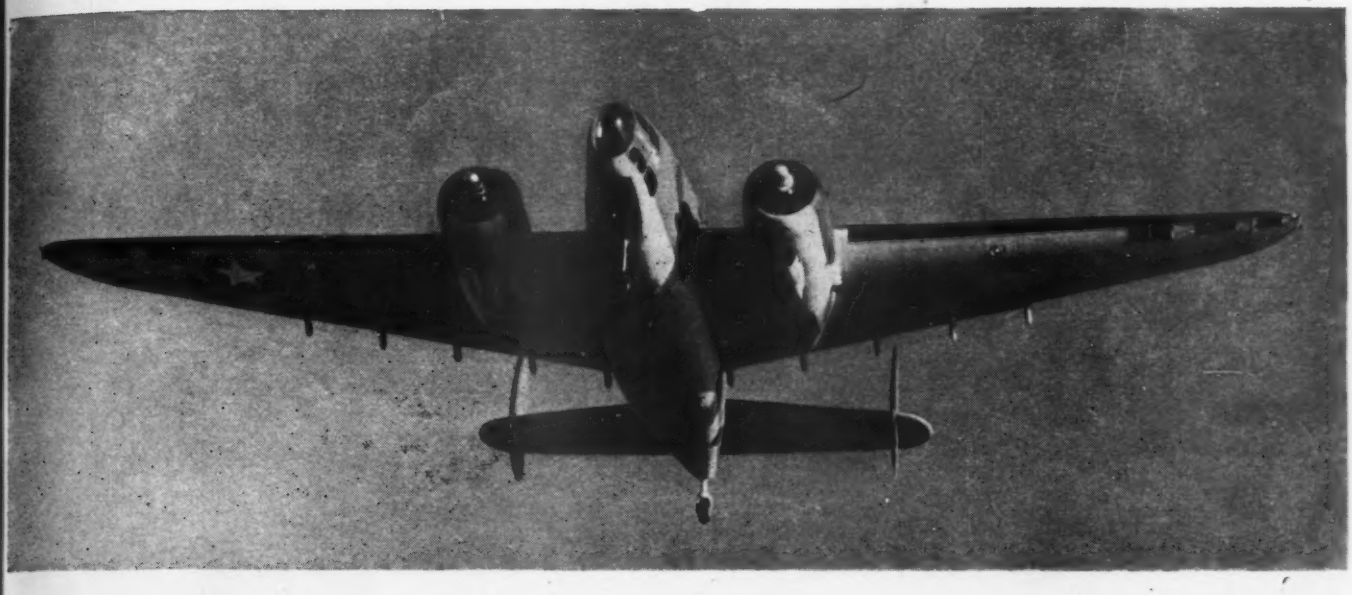
*And in the peacetime to come, these same skills will make the phrase "Built by Boeing" a hall-mark of skilfully designed, soundly engineered, efficiently manufactured products.*

DESIGNERS OF THE FLYING FORTRESS • THE STRATOLINER • PAN AMERICAN CLIPPERS **BOEING**

*THE TERMS "FLYING FORTRESS" AND "STRATOLINER" ARE REGISTERED BOEING TRADE-MARKS

# Yank Modification Center Rises in England

MILITARY



By MYLES V. CAVE, *Aviation's British Correspondent*

**First story on operation of wartime "Little America" where changes dictated by latest battle experience are made on AAF warplanes by Lockheed Aircraft subsidiary.**

LOCATED in an isolated part of the British Isles is a new monument to the constantly growing American war effort. This project, started less than a year ago on an open site by a subsidiary of Lockheed Aircraft Corp., now flourishes as the virile, far-reaching organization of Lockheed Overseas Corp., one of the largest aircraft modification centers outside the continental United States.

With direct Army contracts, Lockheed Overseas has developed a large base, part of which is shared by Army Air Forces units, and in this short period has built a large airport, complete with a network of runways, vast hangars, machine and repair shops, and enormous spare parts storage facilities to handle work on practically every type of aircraft. Here, changes are swiftly made on American fighters, bombers, and transports to conform to latest operational experience needs.

An idea of the extent of the project and the amount of equipment handled can be gained from the wide variety of types seen on the field—Boeing B-17 *Flying Fortresses*, Consolidated B-24 *Liberators*, Lockheed P-38 *Lightnings*, A-29 *Hudsons*, B-34 *Venturas*, Douglas A-20 *Bostons*, C-47 *Skytrains*, Beechcraft personnel carriers, and the ubiquitous Fairchild trainer.

On behalf of the Army, Lockheed Overseas handles any modifications and alterations the Air Forces may require, from an increase in ammunition capacity to extra long range gas tanks for special missions. In addition, a well equipped research department is constantly at work to improve performance, fire power, and bomb capacity of warplanes. During a recent visit to the base the writer saw, for example, one of America's outstanding long range fighters getting increased fire power and performance called for following pertinent experience gained in the North African campaign.

Gen. Mgr. Henry Ogden divides his time between actual supervision at the base and close liaison with Air Forces headquarters, the latter job helping to keep him abreast of latest Army requirements, enabling him to plan ahead and keep output at the base ahead of schedule.

During a three day stay at the base, the writer was given an opportunity to see every department and learn the functional set-up of the organization as well as to examine all the equipment. Except for labor, which is partly local, the base is staffed by hundreds of Lockheed technicians, most of whom have come direct from the home plant in the United States. Much of the time during the visit to the base was spent covering miles on fine concrete roads connecting the various units of which it is comprised—but there was also some time spent in thick gumbo mud.

Presence of the mud does not imply slow progress. Rather it indicates the rapid development, for the speed of building outpaces road-making capacity. This, despite the fact that latest-model American road building equipment is in use.

When the road building program catches up, this base will be the biggest "Little America" in Europe and, without doubt, one of the war's most original American enterprises. The writer spent some 24 hr. attempting to spot even a small item of equipment that did not come from the United States. As for non-American aircraft, curiously enough he saw only one—a British *Oxford* used for transportation.

The superintendent of engineering, James Boyce, and his staff handle each problem individually, from design drafting to the final workout of the scheme in flight. Mr. Boyce—being as short staffed as almost everyone else in the aircraft industry—has no time for specialists and technicians as such; his men must be able to handle everything on a plane. The department does, how-

(*Turn to page* 410)

# Gets into tight spots!

LOOK at that O.D., and you'll know why Apex stud setters get into hard-to-reach places with such ease and precision—even in the hands of semi-skilled workers. These simple, trim, clean-cut stud setters have small body diameters for their capacities. They are extremely easy to adjust for length of thread on stud and maintain proper adjustment in service. Simple design plus ample ruggedness and toughness make them fine tools for either hand or power applications. Four different sizes will set studs up to 1¼". You can get them with Morse taper, hexagon, T-handle and male or female square drive shanks, or combination T-handle with female square for use with a torque wrench. Write for Bulletin No. 101 for all the facts.

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The ***language of lights*** provides silent and safe communication from plane to plane, and ground to plane on our flying fronts. Beams of light, flash-coded recognition and signal messages guide pilots to safe landings, instruct flight squadrons safely and surely. Such messages are safe from enemy interpretation.

They're ***GRIMES*** lights—another example of specialized research and development to help protect and aid those brave flyers on our fighting fronts.

**Grimes Manufacturing Company, Urbana, Ohio**

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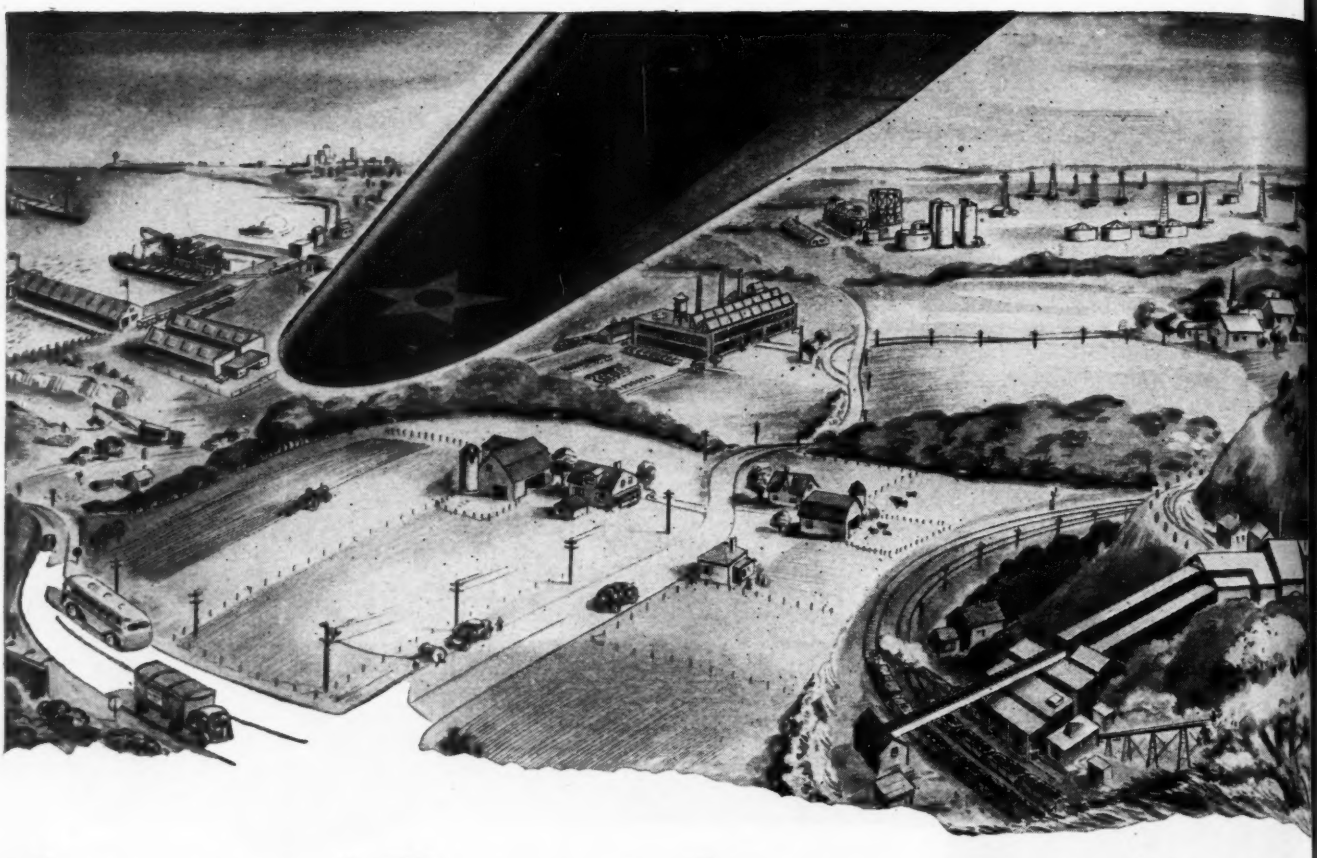
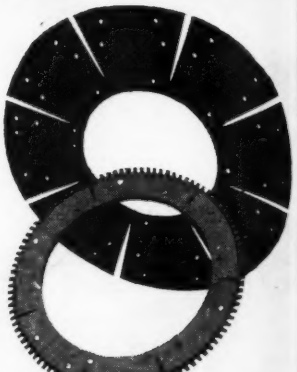


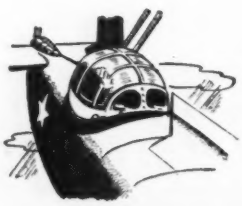
# *Velvetouch Dependability is Established*

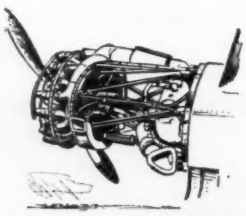
## *on* TWO FRONTS

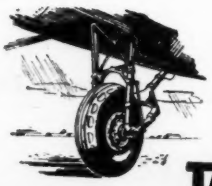
VELVETOUCH Friction Materials are doing an outstanding job in many applications on America's combat planes, notably in landing brakes and in the clutches on engine superchargers, gun turret mechanisms and wing flap controls. On the home front, too, this miracle of powder metallurgy has proven its dependability in all fields where conditions are unusually severe . . . in earth moving equipment, in marine and industrial machinery, in oil well and coal mining equipment, in trucks, busses and agricultural implements. On land and in the air, VELVETOUCH is setting new high standards for smooth, positive operation of clutches and brakes.

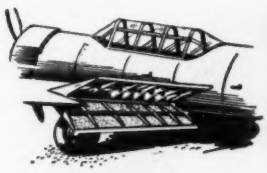


VELVETOUCH is an all-metal friction material—a combination of sintered powdered metals compressed and welded to a solid metal backing. It meets all requirements for clutch and brake applications in the aviation industry.









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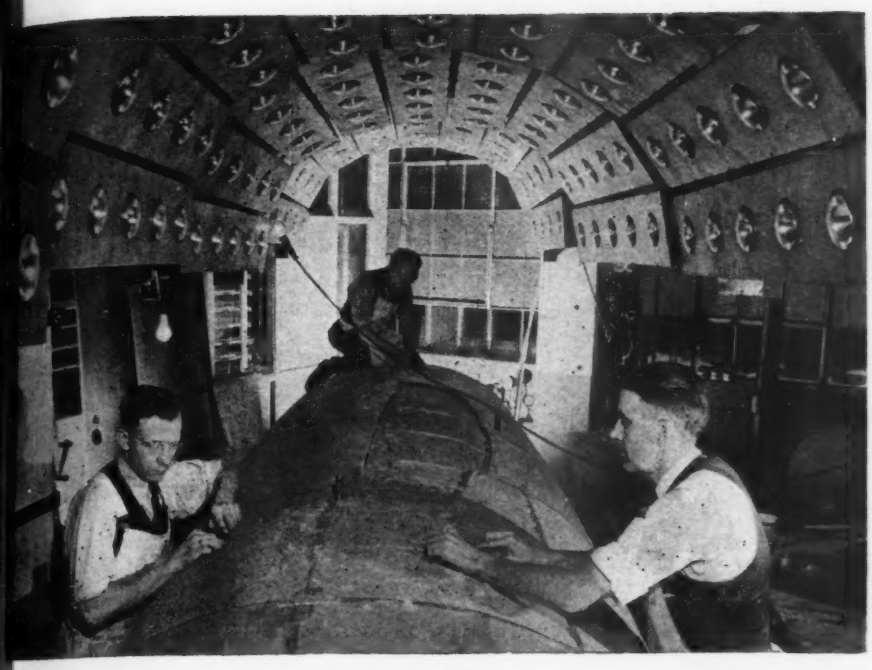


**Initial step** in building de Havilland *Mosquito* bomber is to build up lengthwise fuselage half. Plywood sheets are bent over concrete form, held in place by tacks driven into wood strips set in the concrete. Sheets are bonded by special glue which is dried by battery of 250 infra-red lamps lowered over form. All photos by National Film Board.

# "Mosquito" Design Facilitates Production

By **JAMES MONTAGNES,** *"Aviation's" Canadian Correspondent*

**With plywood fuselage constructed in lengthwise halves, control and wiring installations are simplified. De Havilland Aircraft of Canada uses Packard-built engines in producing these formidable craft.**

IN DESIGNING the now-famed *Mosquito* bomber, de Havilland engineers considered ease of production as well as aerodynamic efficiency, as is evidenced by the rate of production by de Havilland Aircraft of Canada alone.

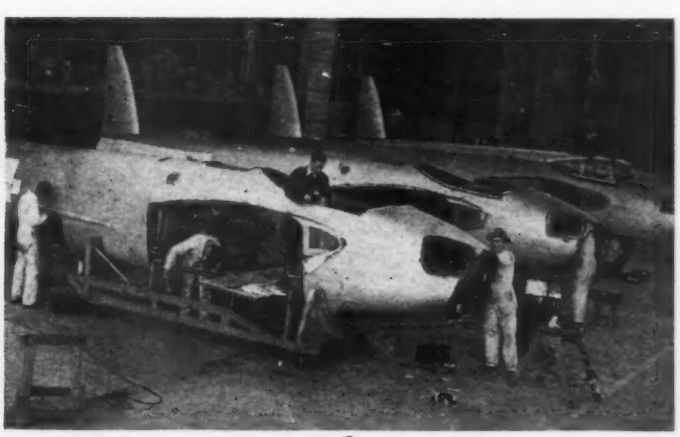
First step in creating the plane is construction of the fuselage in lengthwise halves, which are built up of plywood sheets laid over a concrete form. Shaping of the sheets is achieved by bending them into place on the form and holding them by means of tacks driven into wood strips set into the concrete. Using a special plastic bonding agent, the fuselage is built up to proper thickness, the bonding agent being dried by a battery of 250 infra-red lamps. One of the largest such batteries in Canada, the infra-red unit was designed especially for *Mosquito* production.

Other structural sections of the fuselage, such as the five main bulkheads, are built up from smaller pieces of wood, which are cut, bent, and bonded on molds before being bonded as an integral part of the fuselage of the *Mosquito*.

This work is done in one plant, the halves then being shipped to the company's main plant outside Toronto. Here the two halves are set up in fixtures and all possible wiring and control installations made. This system eliminates the necessity of employees working in cramped space, thus speeding production considerably. When the two halves of the fuselage have been fitted and bonded into one unit, the whole is fabric covered.

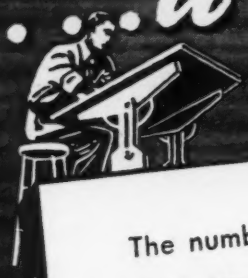
Moved then to the final assembly area, it receives the empennage and ply-

**Fuselage halves, with bulkheads in place,** receive interior finishing touches at de Havilland Aircraft of Canada. Note tongue and groove fitting for joining the two components into one unit.



***Mosquito* fuselages near final assembly area.** All possible wiring and controls have been installed before the lengthwise halves were bonded together, when complete fuselage is fabric covered.

# ...it can be simplified!



The number of moving parts in any mechanical assembly is an important consideration. A reduction in the number of parts often means greater efficiency in operation and lower cost of production. That's elementary knowledge to every manufacturer.

But many times the manufacturer is too close to the woods to see the trees. He's grown up with his product and is convinced that it is just as simple as possible. Spriesch men have amazed many experts by insisting it can be simplified. We've done it with highly complicated, precision-demanding aircraft armament devices such as automatic bomb-release racks and shackles and cannon feeds.

As a matter of fact, that's why Spriesch now is working 24 hours daily, producing this highly specialized materiel—delivering it on time with a remarkably low percentage of rejections. Spriesch miracle war production is the talk of the country.

Frankly, we seek contact now with responsible people who desire to improve present mechanisms... to develop new mechanical ideas... to produce parts or complete assemblies, experimental or mass production... AFTER VICTORY. Our 36-page brochure "Ingenuity" will give you a complete picture of our physical plant... at the same time will portray our spirit.

Joseph J. Cheney, President.

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"INGENUITY" ★

★ Spriesch *Established 1923*

TOOL & MANUFACTURING CO., Inc.

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Ad No. 16

**Final installation** of instruments and electrical units in nose section of *Mosquito*. Transparent nose section will be added only after tests have been made on bomb rack and bomb bay door operations. Access to plane is via collapsible metal ladder through small hatch in floor, below bombardier-navigator's seat on right side of plane.

**One of five major bulkheads of *Mosquito* fuselage.** These are built in halves as sub-assemblies, then joined together by plastic bonding.

wood wing, the latter with landing gear already attached.

The aircraft is then placed in jigs which keep it in flying position as it moves through the final assembly area where engines, nacelles, bomb racks and doors, instruments, self sealing fuel tanks, and other units, are installed.

The plastic cockpit cover is put in place after the armor-backed pilot's and bombardier-radio operator-navigator's seats have been installed. The transparent plastic nose is put in place after the bombardier's instruments are all in and all controls for operating bomb racks and bomb doors have been tested.

Access to the plane is through a small hatch via a collapsible metal ladder. The bombardier's seat is to the pilot's right so that the bombardier can drop down and lie full length over the hatch opening with the upper part of his body in the nose of the plane where the bomb sight is located.

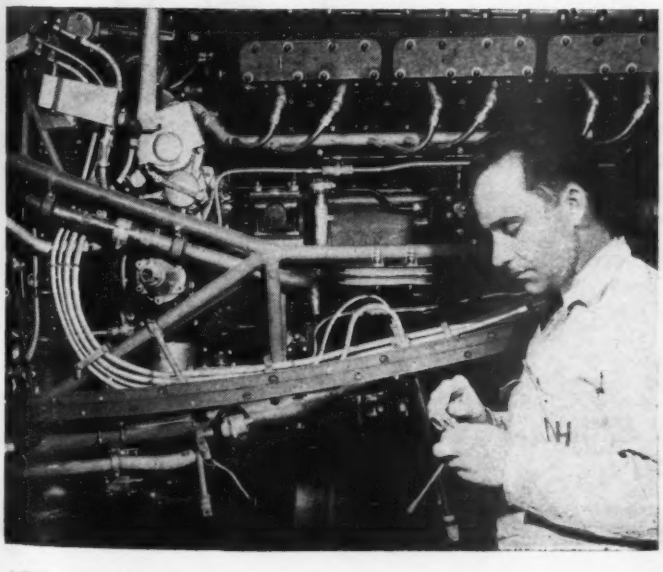
When the *Mosquito* was first put in production in Canada, some of the instruments were made in England. Now, however, these are being replaced with Canadian and American built units, some of which have required considerable modification in the original cockpit layout and wiring.

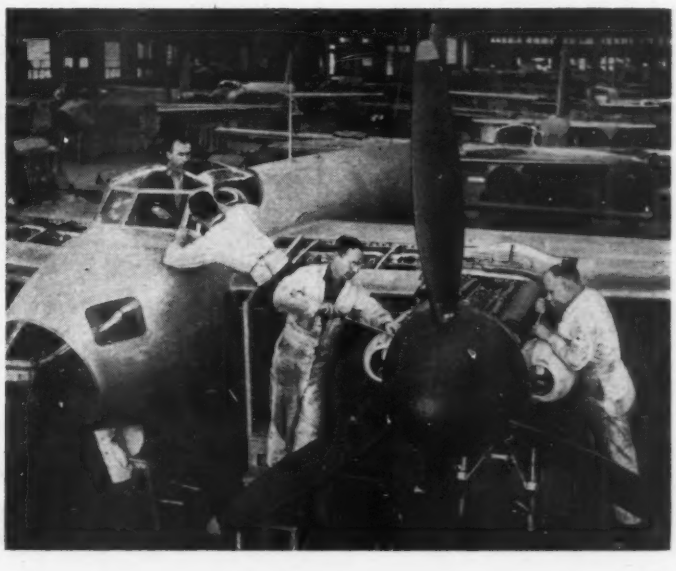
Canadian-built *Mosquitos* are powered by Packard-built Rolls-Royce *Merlin* 21 engines developing 1,250 hp.

Releasable specifications include the following: Span, 54 ft. 2 in.; Length, 40 ft. 9 in.; Height, 15 ft. 3 in.; High speed (approx.), 400 mph.; Range (maximum), 2,000 mi.; Armament (reported), four 20-mm. cannon and four 0.303 machine guns; Power, 2 Packard Rolls-Royce *Merlin* 21's.

**Detail of engine mount** for one of two Packard-built Rolls-Royce *Merlin* 21's which give *Mosquito* top speed of approximately 400 mph., making it one of world's fastest.

**Final assembly area** of de Havilland Aircraft of Canada's main plant producing *Mosquito* bombers. Employees at right install exhaust flame dampers while those at left secure cockpit cover for crew of two: Pilot and bombardier-radioman-navigator.





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***DEPENDABLE*** — because Oster's peacetime requirements have always called for the very qualities which are essential in war applications: Light weight, maximum power in minimum space, precision manufacture, ability to stand up under abuse.

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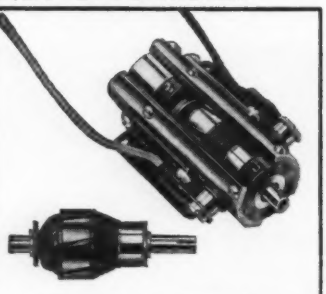

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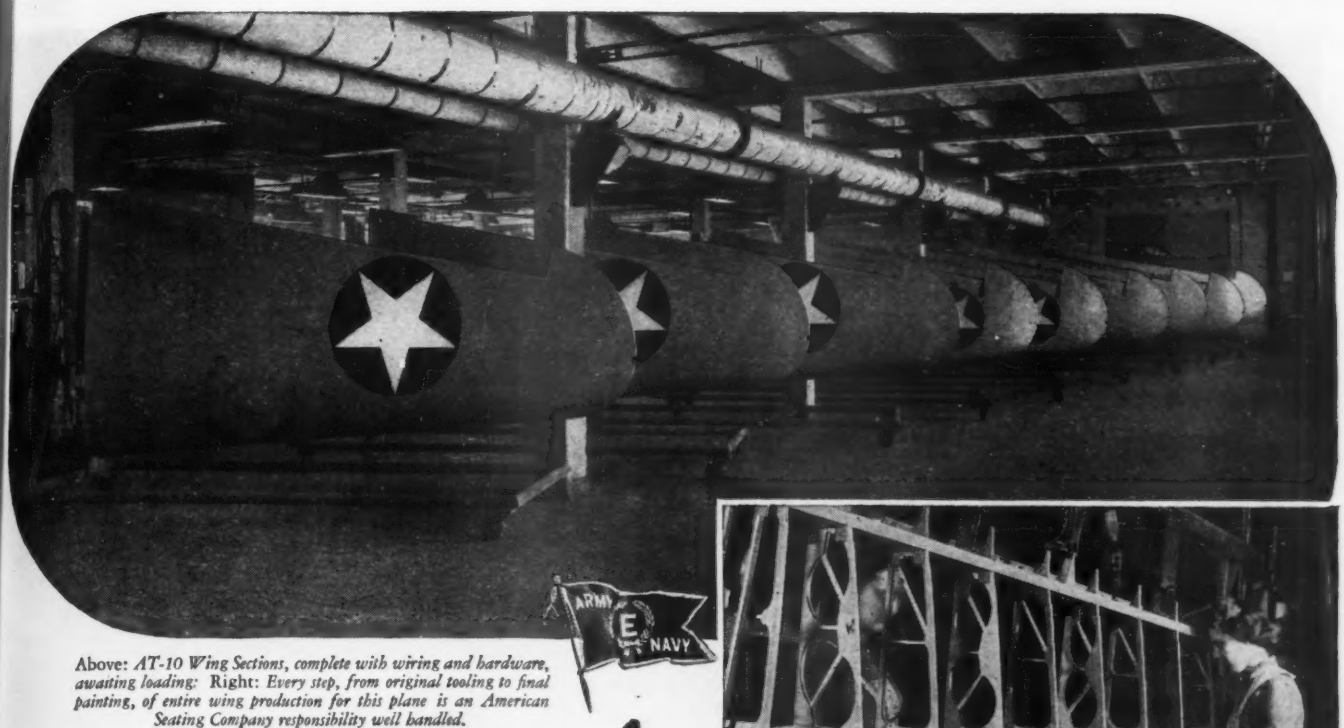
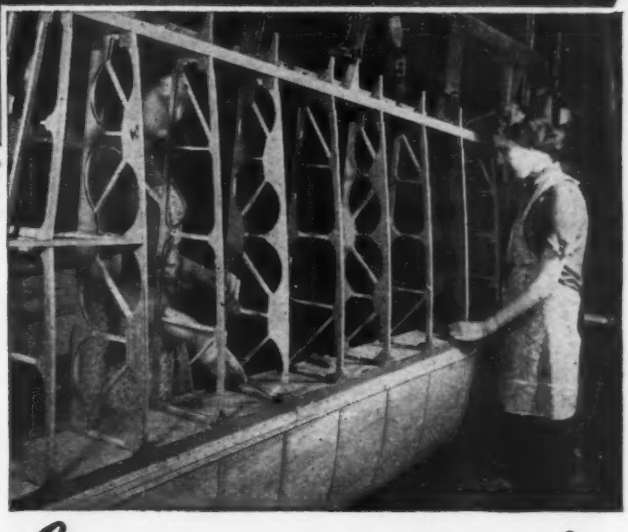
Complete in housing: 1½" dia. by 2$\frac{3}{32}$" long to 3½" dia. by 5½" long. Windings: shunt, series, or split-field 3-lead reversible series. Also permanent magnet motors 1" dia. by 2$\frac{3}{32}$" up.




Above: *AT-10 Wing Sections, complete with wiring and hardware, awaiting loading:* Right: *Every step, from original tooling to final painting, of entire wing production for this plane is an American Seating Company responsibility well handled.*



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**3** FLEXIBILITY proved by swift development and production of new type pilot seats (standardized and special-purpose), using plywood and metals in their most effective application.

**4** VERSATILITY proved by the development of our own jigs, tools, fixtures, methods for volume production in metal or wood, of any project we undertake.

To aircraft production engineers in need of thoroughly reliable supplemental capacity, American Seating Company will furnish craftsmanship that is self-starting, resourceful, and accustomed to quality and efficiency standards which you will thoroughly approve.

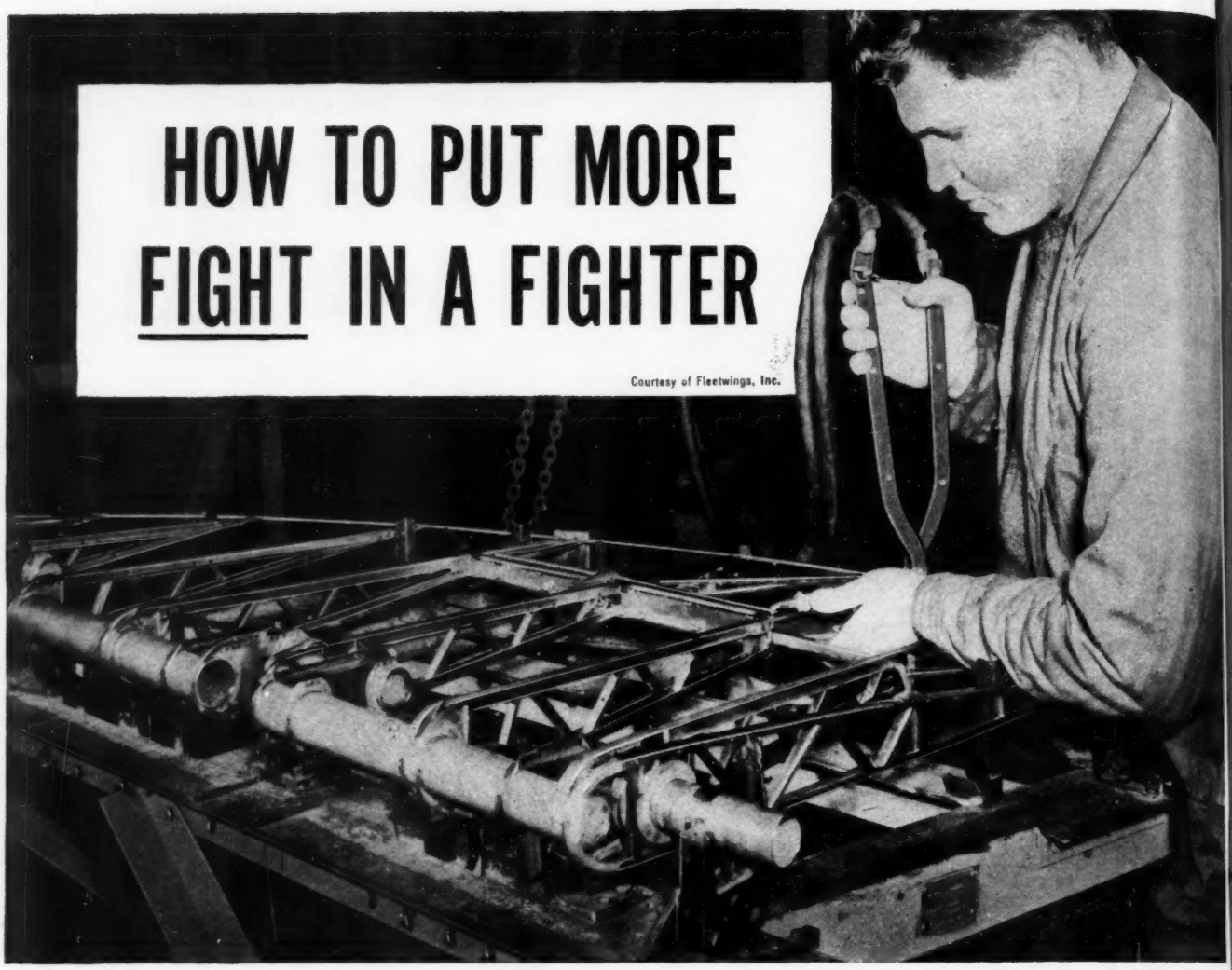
*This American Seating Company new type pilot seat won prompt approval; is currently standard on several warplanes; conserves critical materials; possesses unique advantages.*

## *American Seating Company*

GRAND RAPIDS, MICHIGAN

**WORLD'S LEADER IN PUBLIC SEATING**

Manufacturers of Theatre, Auditorium, School, Church, Transportation and Stadium Seating • Branch Offices and Distributors in Principal Cities




## U·S·S Stainless Steel has what it takes to give war planes the battle stamina they must have

EVEN though stainless steel must be conserved wherever possible, its use is encouraged for the more critical structural parts of war planes because of its tremendous operating advantages.

Take elevator frames, rudder frames, aileron struts and stabilizer frames, for example. The high strength of U·S·S 18-8 Stainless Steel makes it possible to obtain a favorable strength-weight ratio in any of these important parts. Its high corrosion resistance eliminates the need for making any allowance for weakening, and adds to the efficiency of control operation. Longer combat life and low maintenance result from stainless' resistance to fatigue, shock, heat and abrasion. And stainless construction of aileron frames permits counter-balancing with considerably less weights.

U·S·S Stainless Steel helps to speed fabrication and lower shop costs, because its ready spotweldability and formability enable aircraft builders to take full advantage of the latest improvements in plane design and fabrication techniques.

The full effectiveness of America's Air Forces demands that every pound of stainless steel be used where its unique advantages will give the most fighting punch to our aircraft. If you have any problems in your use of stainless, let us help you work out the best answers. Our metallurgists are at your service, at no obligation to you. Simply write, and put your problems up to us.

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York

# U·S·S STAINLESS STEEL

*Sheets · Strip · Plates · Bars · Billets · Pipe · Tubes · Wire · Special Sections*

# UNITED STATES STEEL

## Texas Today—Tokyo Tomorrow

*International News Photo*

Scale drawing of enemy territory is magnified on a screen by "projection bombing trainer," newest Army wrinkle for simulating actual raiding conditions. Bombardier cadet at Midland, Tex., school, is seen taking aim.

# CIVIL OPERATION AND TRAINING

### FCC Authorizes CAP Radio Stations

Establishment of radio stations "to be used exclusively for essential communications relating directly to the activities of the Civil Air Patrol" has been authorized by the Federal Communications Commission. This ruling grants frequency bands for CAP civilian stations and has no effect upon military transmitters used by pilots while on official missions.

A four-hour-credit course in radio telephone operation, similar to that required of applicants for War Emergency Radio Service permits, is being offered to members who expect to use the new frequencies. Texts are a new training directive (No. 32) and CAA manual, *Standard Airport Traffic Control Procedures Part I.*

Few other details have come from Washington, but the plans of the Missouri Wing indicate how the new service may be organized in other parts of the country. Theoretically, the equipment is similar to that used by War Emergency Radio Service, but since it and other agencies have priority on what is available, Missouri members have been constructing their own sets from whatever parts they can find. They expect that the station license will be issued on a blanket basis. Frequencies will probably be 115.3, 115.5, 115.7, a d 115.9 megacycles, their use to be restricted to emergencies or training maneuvers. Missouri flyers anticipate that they will have one portable ground station, normally located at squadron headquarters, and several radio-equipped planes in each squadron.

### WPB Order Puts Private Planes in War Service

Civilian plane owners who have not assigned their craft to the Civil Air Patrol may lose them through requisitions of government agencies as a result of WPB's limitation order L-262 freezing in the hands of their owners all aircraft of 500 hp. and less and also Link trainers (page 281, March AVIATION).

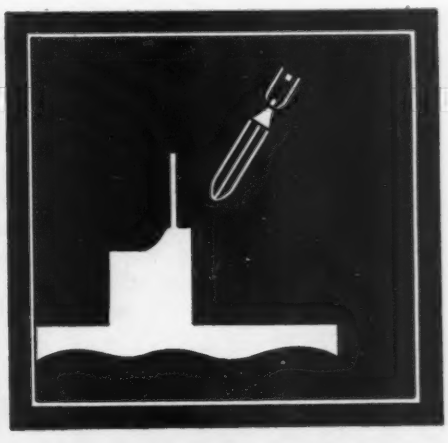
"Purpose of this order," says OCD, "is to limit flying to wartime purposes. With a limited supply of aircraft remaining in civilian hands, some redistribution of them under the WPB order is inevitable."

Under a specially developed price formula, owners may transfer their planes to CAP for active duty for the duration. Through local wings, they should submit to national headquarters data regarding make, year, and model of their plane, make and horsepower of engine, total hours, and condition.

With all CAP planes on active duty now bearing "A" certificates, issued by Washington both as insurance against requisitioning and as priority ratings for spare parts, there is no guarantee that an owner will always fly his own plane on missions. Ships will simply be assigned to operations in a ratio of about one emergency standby to three on service.

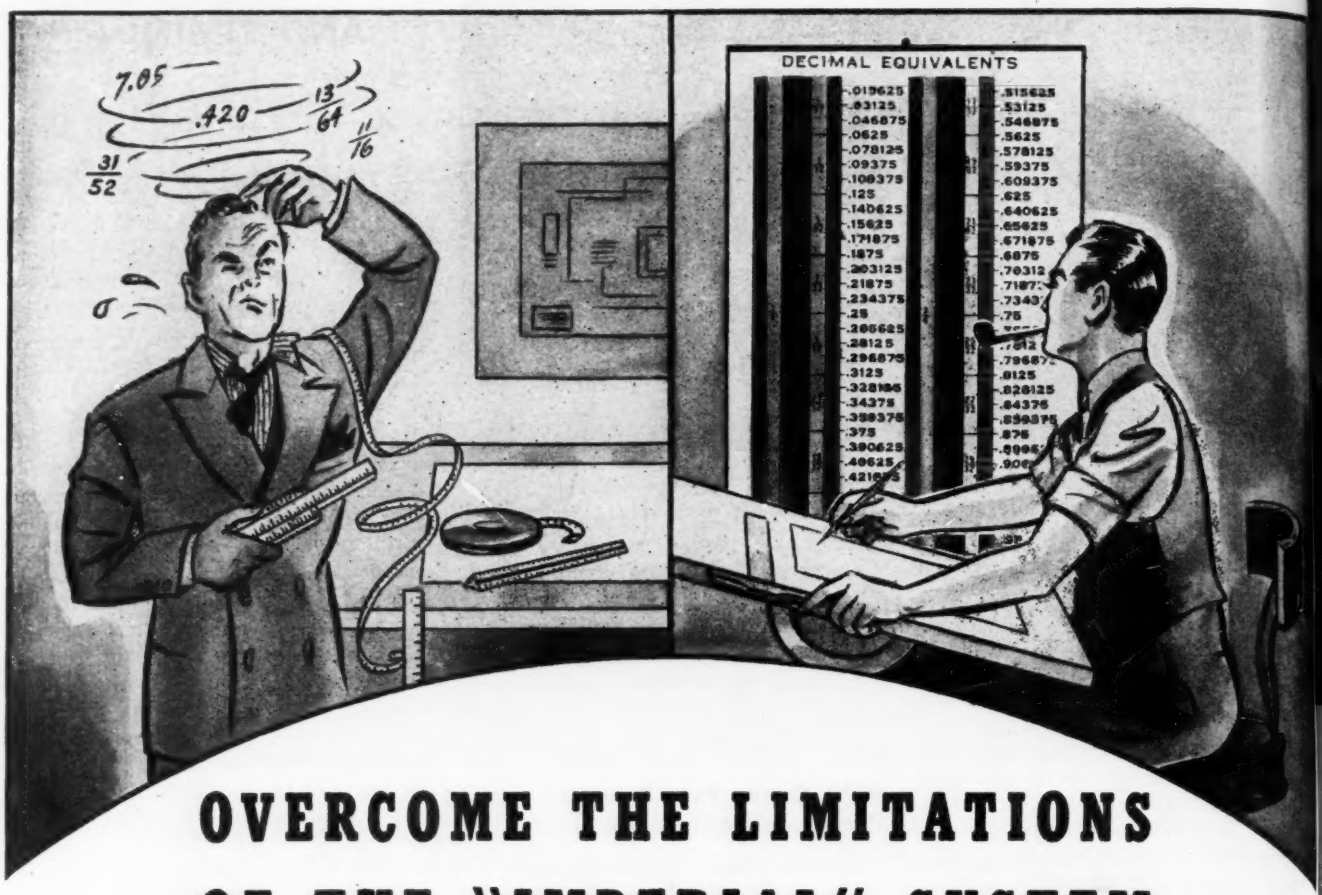
CAA has also issued new regulations on plane registrations and identification of pilots. All flyers are now required to carry with their pilot's certificates identification cards bearing fingerprints, photo, and signature (Amendment 20-3).

(*Turn to page* 268)



**Blossoms of a serious spring,** these emblems are being worn by CAP flyers on submarine and forest patrols. "While opportunities for forest-area patrols will be limited," Washington announces, "emergency missions may be flown by 'B' planes without changing their status where no CAP craft in the 'A' category are available." A and B categories are explained in accompanying story titled, *WPB Order Puts Private Planes in War Service.*

# *How do* YOU *do it?*




## OVERCOME THE LIMITATIONS OF THE "IMPERIAL" SYSTEM

- The "IMPERIAL" is the customary system of measurement used in the British Empire and in the U. S. A.

  From the beginning of time, man has striven to unify and simplify his measurements.

- The "CUBIT" . . . oldest known measure of length, varied, but averaged 21.8" . . . Egypt had 3 different cubits, 17" for the common man, 21" for the King, and 35" for the Sanctuary.

- The "FOOT" . . . originated in Greece . . . became the standard unit of length in the early Olympic Games . . . reputed to be the length of Hercules' foot. Romans based their system upon the Greek method, and forced their Romanized code of measurement upon England. When Britain was again free, this Roman-Greek system was modified . . . and thus started the "IMPERIAL" system.

- The "YARD" . . . originally the circumference of a man's body, later the length of the first King Henry's arm . . . still later became a multiple of the foot.

- The "INCH" . . . the length of 3 barley corns . . . later became 1/12th of a foot.

- THE LIMITATIONS ARE THAT THESE UNITS ARE NOT MULTIPLES OR UNITS OF DECIMALS.

  Modern Engineering and Manufacturing demand flexible and precise standards . . . hence the use of Decimal Equivalents.

  Time will not permit individual interpolations.

- The CONTINENTAL-DIAMOND Decimal Equivalent Chart is an indispensable aid to crash through the limitations of the "IMPERIAL" system . . . in colors . . . 23" x 35" . . . easily read . . . gives Decimal Equivalents from 1/64th" to 64/64"

  Write today for your free copy. Address 12 Chapel St., Newark, Delaware.

**Continental-Diamond FIBRE COMPANY**

*Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE*

*Craftsman? Yes Sir! This American Bosch girl is a highly skilled specialist---modern interpretation of the New England tradition*

# Here Arctic and Equator are only Seven Miles Apart

THERE may be only seven miles or so between a plane's service ceiling and the burning desert floor... but the temperature spread is as great here as it is between the North Pole and the steaming tropics. That calls for flying equipment that can take the gaff at 70° below and — only minutes later — 150° above.

American Bosch magnetos in U. S. planes are ready to take this punishment from the thermometer; they deliver rich high-tension sparks at the *right* split-second of time . . . now to altitudes far higher than ever before.

Superior American Bosch *design* is backed by similarly superior *production.* Thousands of units move swiftly into service, thanks to our large staff of *specialist* craftsmen . . . many of them relative youngsters who — through engineering, planning, training, and tooling—have gained the skill to do *few* operations *extremely well.* That's the modern American Bosch development of the New England tradition.

In research, design, and production—war or peace—American Bosch serves all branches of the internal combustion engine industry.

AMERICAN BOSCH CORPORATION • SPRINGFIELD, MASSACHUSETTS

# AMERICAN BOSCH

AVIATION AND AUTOMOTIVE ELECTRICAL PRODUCTS . . . FUEL INJECTION EQUIPMENT

MODERN CRAFTSMEN IN THE NEW ENGLAND TRADITION

Rulings on "recordation of aircraft ownership" and "aircraft registration certificates" are covered in Regulations of the Administrator, parts 501 and 503, respectively.

Registrations for CAP "B" planes, those not assigned by their owners to active service, still pend interpretation of order L-262 on renting of ships for training, a practice which one private Washington source advises be "stopped immediately."

War Training Service requisition of "B" planes is about complete, and OCD admits that "this will curtail CAP flight training in some areas but that enough planes will be left for extensive activities."

Washington has made the following decisions governing relations between private contractors, who may retain ownership of their planes, and WTS: (1) those flying government ships on the Army cadet 10-hr. program will be paid $11 per hour; those flying their own planes will get $12.70; (2) flight instructors' minimum salary will be $250 per month; (3) WTS contractors have repair parts priority rates equal with other military training schools; (4) the 10-hr. course may be extended to 20 hr., but present pay rates are no indication of terms of future contracts.

## On Patrol

• A series of emergency CAP "E" stations has been organized in Michigan. Set up near highways, they are manned 24 hr. a day by a pilot, observer, and ground assistant who stay in shacks or tents which are stocked with blood plasma, various medicants, and paper-made parachutes. Communications are maintained with hangars and two reserve crews which are always on call. Barbed wire and other blockading materials are provided for restricting public access to airports in emergencies.

Accustomed to keeping war plants fed with materials, CAP has also filled empty stomachs. Flying from Oklahoma City to Durant, Okla., Lt. Charlie Rhoades carried 5,000 ration books for a 5 o'clock rush registration of war workers. The books weighed 130 lb. and were worth only OPA knows how many pounds of meat.

Massachusetts Wing is promoting collection of funds by distributing winged pins lettered "CAP" in red and white to donors of $2 or more. Several thousand dollars collected have been used to buy radios, parachutes, and to maintain a revolving fund for pilots waiting for federal checks.

Three former lady pilots of Squadron 613-3, Chicago, are training with the Women's Auxiliary Ferrying Service.

Drilling two hours a week and attending first aid classes with Flight 213-3A, Montour Falls, N. Y., is the country's oldest pilot, A. I. Martin, 81-yr. old operator of the local airport, who has passed the physical examination for a commercial license. On his office wall hang an ox yoke and the propeller of the plane in which he made his first solo flight, reminders of how his means of travel have changed.

A new set of CAP rules is now being submitted to the wings for check before final promulgation. Washington says that "among the new features will be a merit system based on completion of training directives and aeronautical ratings for the grading of members. Minimum standards will be set for service as an officer or non-com. . . . The ground training directives in drill, first aid, and other necessary subjects must not be skipped . . . The new rules will give a reasonable time to catch up, but the time to start is now."

**Congratulations** for efficient training of airplane mechanics are extended to Aviation Institute of Technology, Long Island City, N. Y., by Brig. Gen. Junius W. Jones, commanding general, first district Technical Training Command. Honors in TTC second district were won by Briggs Mfg. Co., Detroit, whose efficiency rating was 95.6 percent. Buick was next with 94.3 percent.

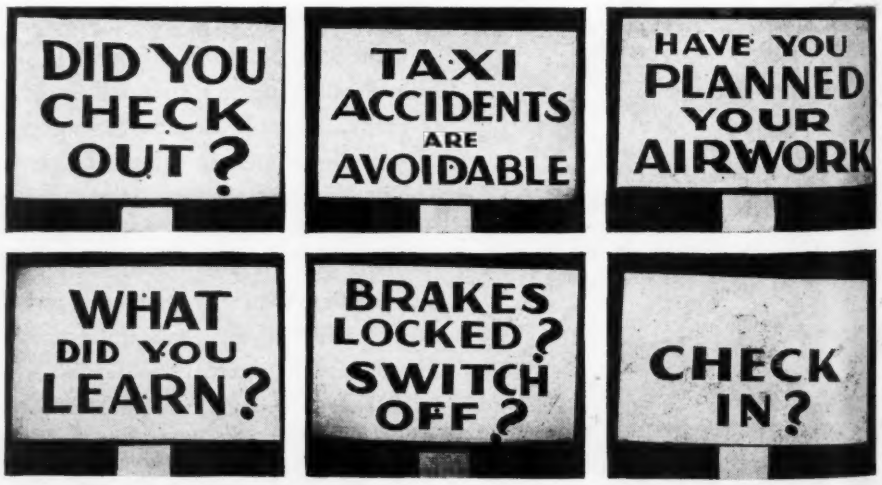
CIVIL OPERATION AND TRAINING

## Along the Apron

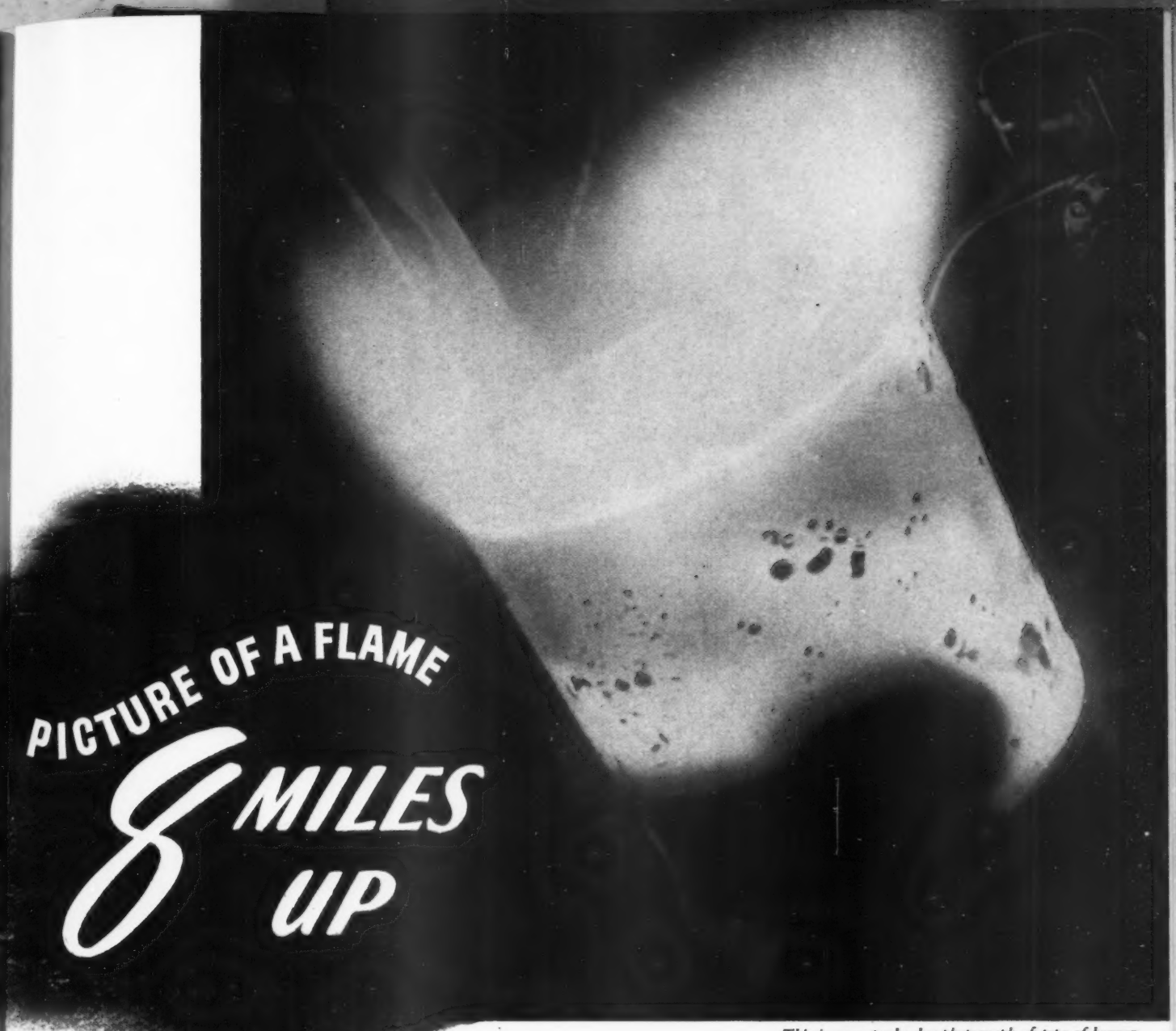
• Preparing for an expected proportion of 50 percent women among its personnel before the war is over, Ohio Crankshaft Co., Cleveland, has begun a series of twelve-day, two-hour training periods. New workers spend six hours a day in supervised shop work at regular pay rates and make up the remaining time of their eight-hour shift in classrooms.

A teacher's kit of junior aviation instruction material for use in schools is being distributed by Piper Aircraft Corp., Lock Haven, Pa. It contains a color photo of an Army-type Piper *Cub*, nomenclature wall charts of instrument panels and control movements, and a blueprint for building a scale model of a *Cub* trainer.

The Army Flying Training Command has established a second women's pilot training school at Sweetwater, Tex., with nearly double the capacity of the original establishment at Houston. New and somewhat relaxed requirements are being prepared for the 22½ week course,

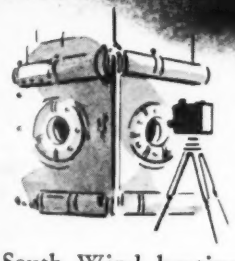



**Final reminders,** signs above are among those planted along walk leading to flying line at Enid Army Flying School, Enid, Okla. Their reverse sides have more questions for cadet returning from a flight.



# PICTURE OF A FLAME 8 MILES UP

*This is an actual color photograph of type of burner used in the new improved South Wind Aircraft Heater.*



THE simplest way to find out what will happen to vital equipment at an aircraft's ceiling—is to *look!* So South Wind experts adopted means of "looking" at the performance of South Wind heating equipment at top altitudes—with bulky test equipment that couldn't be carried in a plane.

Typical of many of the advanced facilities used regularly in Stewart-Warner's South Wind laboratories is an altitude chamber—specially designed for exacting tests of aircraft heating equipment.

Here—under simulated flight conditions—each detail of South Wind performance is pre-checked. Operations normally hidden from the eye are exposed and studied.

For example, as pictured above, the "burners" of the recently developed ram-air operated South Wind Heaters were put through their paces at the equivalent of 20,000—30,000—40,000 or more feet. Their combustion characteristics were analyzed. Their performance was perfected. So that they could be delivered with performance as fully proved in advance as the most complete, modern engineering facilities could make it.

The result is a line of South Wind Heaters delivering far more Btu/hrs. per pound of weight—far simpler, lighter, requiring no blowers or motors—and providing new dependability right up to the ceiling of flight.

Thus Stewart-Warner's long years of cooperation with aircraft engineers—its superior engineering facilities—and constant field contact with actual operational requirements—continue to keep South Wind ahead in contributing to the solution of urgent aircraft heating problems.

ARMY E NAVY

## South Wind Heaters

REG. U. S. PAT. OFF.

HEATER DIVISION, STEWART-WARNER CORP., CHICAGO

Another Product of STEWART WARNER

*West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service, 1273 Westwood Blvd., West Los Angeles, California*

# CARRIER PIGEON!

*U. S. Navy Official Photograph*

**The Navy's new "carrier pigeons"—Vought Corsairs—are built to outspeed, outclimb, outmaneuver and outshoot all enemy carrier-based raiders.**

**Goodyear Aircraft is now going into production of these deadly fighters designed by Chance Vought Division, United Aircraft Corporation.**

**Goodyear's long experience with metal fabrication will be a big factor in speeding up Corsair output. In the rugged flight testing and delivery of these battleplanes, Goodyear relies on Sinclair Pennsylvania Motor Oil for safe lubrication.**

*FOR FURTHER INFORMATION ABOUT SINCLAIR PENNSYLVANIA AND OTHER SINCLAIR AIRCRAFT LUBRICANTS WRITE*

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## KEEP POSTED ON

# Products & Practices

**This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save invaluable time, provides profit through convenience. To obtain literature or additional data on new products described, simply fill in form below,* clip it to your letterhead, and mail. There is no cost, no obligation.**

**Steel Analysis Chart..... 1**

Embracing all modifications in analyses of AISI, SEA, and new NE steels to February 1, folding chart issued by American Steel & Wire Co., Cleveland, shows which products are available in specific analyses and components used in producing various grades of steel.

**Products Data ..... 2**

Photos, descriptions, engineering drawings, and specifications on pressure sealing control guide bushings, anti-icing propeller covers, cable and tube pressure sealing bushings, and cable guide bushings have been issued on single sheets, punched for ring binders, by Firestone Aircraft Co., Akron.

**Metal Washing Machine..... 3**

Circular describing mechanical features, construction, operation, and specifications of new Tumbl-Spray metal washing machine designed for removing chips, dirt, grease, and oil from machined parts and stampings has been issued by American Foundry Equipment Co., Mishawaka, Ind.

**Re Shear Tests ..... 4**

Data compiled during a series of shear tests requested by a major aircraft manufacturer and conducted by Triplett & Barton, Los Angeles, on Nigg cowl fasteners, are being released to other manufacturers. It is reported that fasteners under test withstood an average ultimate load more than twice the AN-F-8 requirements of 1,050 lb.

**Radial Tapper ..... 5**

For production work where it is easier to move arm of tapping machine than work, Bakewell Mfg. Co., Los Angeles, has produced radial tapper with capacities of 4-40 to ⅜ in. in steel. Particulars are contained in Bakewell Catalog No. 1-R.

**Arc Welding Suggestions..... 6**

Under title *Factors Affecting Increased Welding Production*, Lincoln Electric Co., Cleveland, is distributing 42-page booklet on 15 phases of welding technique.

**Electric Timers ..... 7**

Construction, standard and special features, motor styles, and applications of Cramer multi-contact timers for controlling off and on sequences in electrical circuits are described and diagrammed in Bulletin 3000 issued by R. W. Cramer Co., Centerbrook, Conn.

**Service Bulletins ..... 8**

New and revised service bulletins from Scintilla Magneto Div., Bendix Aviation Corp., Sidney, N. Y., are No. 67C (superseding 67B) on *Treating Dielectric Parts Against Moisture Absorption*, No. 100 on *Discontinued Molded Type Coils* (types PC, SB, SF 4, 5, and 6 cylinder series magnetos), and No. 103 on *Radio Shielded Harness Electrical Leakage Test* (all harness types).

**Filter Catalog ..... 9**

Loose-leaf catalog presenting story of Skinner filters "from principle to installation" is available from Skinner Purifiers, Detroit. There is special section on aviation units.

**Brazing Applications ..... 10**

Latest edition of *Low Temperature Brazing News*, Handy and Harman, New York City, contains examples of new time-saving brazing applications. The company's *Bulletin No. 12* contains fuller details.

**Aircraft Veneers..... 11**

Prepared and distributed by the Central States Aircraft Veneer Committee and the American Walnut Manufacturers Assn., *The Inspection of Aircraft Veneers* is an interpretation of Army-Navy Aeronautical Board specification AN-NN-P-511b. It contains photos and data which have been reviewed by the Forest Products Laboratory and the AAF engineering division, Wright Field.

**Preservation of Drawings..... 12**

How to preserve, restore, and duplicate original drawings is explained in booklet from Keuffel & Esser, Hoboken, N. J. Described is company's "Photact" process, providing reproduction papers and cloths duplicating originals, with prints serving as "masters."

**Metal Cutting ..... 13**

Reprint of a lecture, *Physics of Metal Cutting*, delivered before national metal congress of American Society for Metals by Hans Ernst, director of research, Cincinnati Milling Machine Co., is available from firm.

**Underwriters' Report ..... 14**

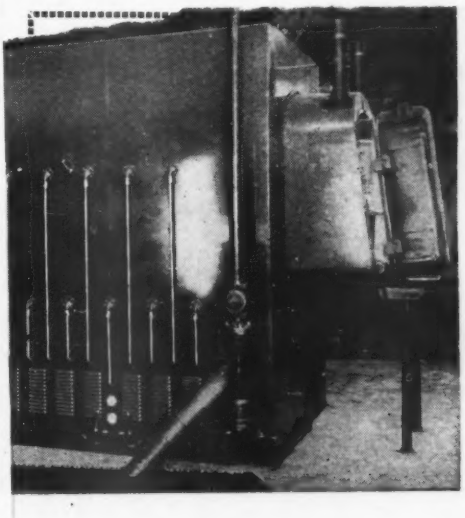
*List of Inspected Fire Protection Equipment and Materials* is title of latest semi-annual 173-page report issued by Underwriters' Laboratories, New York, Chicago, and San Francisco.

**Hydraulic Equipment Listing..... 15**

Blackhawk Mfg. Co., Milwaukee, has issued Catalog V-43 covering its 3- to 50-ton hydraulic hand jacks, wheel service and gage-equipped jacks, hydraulic units, maintenance kits, motor vehicle assortments, and pipe benders.

**Faster Finishings ..... 16**

Coming off press is *Blueprint for Faster, Better Production With Coated*



*with your design-engineering and fabricating problems. Carpenter's series of QUICK FACTS bulletins can help you get the most from Welded Stainless Tubing. They can help your new men become more familiar with accepted fabricating methods. A note on your company letterhead will start a series of QUICK FACTS bulletins on the way to you. Write us today.*

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Welded Alloy Tube Division, Kenilworth, N. J.

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Independent laboratory tests of Booth mechanical felt parts are surprising design engineers as to the ability of felt to serve *better* in scores of aircraft and machine applications.

Booth "prescription" felts are made to fit the task . . . with ingredients "compounded" to give the exact end properties desired in the precision-cut parts. It may pay you to know the properties and savings obtainable. Write for the Booth condensed textbook, "The Technique of Felt Making." The modern felt technology described, may be a revelation to you.

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482 19th Street, Brooklyn, N.Y.
745 Sherman Street, Chicago, Illinois


## INFORMATION TIPS

*Abrasives*, technical booklet in three colors prepared by Behr-Manning Corp., Troy, N. Y.

**Wheel and Point Literature** ..... 17

Released by Bay State Abrasive Products Co., Westboro, Mass., is descriptive booklet on its mounted wheels and points. Included are price and specification sheets and folder describing manufacturing process.

**Protection for X-Ray Workers** ..... 18

Ray Proof Corp., New York City, announces new literature on materials and methods for protecting X-ray laboratory personnel and maintaining light-proof equipment.

**Wood Grain Chart** ..... 19

For determining strength of aircraft lumber by slope of grain, California Panel & Veneer Co., Los Angeles, is distributing *The Ostlind Slope of Grain Chart* incorporating strength-determining formula.

**Synthetic Elastomer** ..... 20

Dow Chemical Co., Midland, Mich., has issued new technical sales bulletin describing properties and fabrication techniques for Styraloy 22, synthetic thermoplastic resin of hydrocarbon type offered as a cable insulating material.

**Handling Stainless Steels** ..... 21

Special service report, *The Fabrication and Surface Treatment of Stainless Steels*, prepared by Oakite Products, New York City, covers machining, grinding, drawing, and forming operations, and surface preparation.

**Insulated Bushings, Mountings** ..... 22

Line of insulated bushings and mountings, designed to stop vibration, absorb shock, and reduce wear, is described in folder and engineering data sheet compiled by Bushings, Inc., Berkley, Mich.

**Management Practices** ..... 23

From study of 44 companies in wide variety of industries has come cross-section of management practices under title, *Controlling Factory Production*. Publisher is Policyholders Service Bureau, Metropolitan Life Insurance Co., New York City.

**Precision Grinders** ..... 24

Catalog No. 42 issued by Dumore Co., Racine, Wis., contains drawings, illustrations, and specifications of wide variety of firm's precision grinders.

**Chip Breaker Charts** ..... 25

McKenna Metals, Co., Latrobe, Pa., announces three-color, wall charts with dimensional diagrams for correct grinding of parallel, angular, and groove-type chip breakers. Charts project dimensions for all three types in relation to depth of cut and feed.

**War Products** ..... 26

Westinghouse Electric & Mfg. Co. developments and products now being used by American air, sea, and ground forces are depicted in booklet *Westinghouse Wartime Engineering*.

**Smoke Meter** ..... 27

Photoelectric smoke meter, designed to indicate smoke from Diesel and internal combustion engines and furnaces, is described in bulletin from Photovolt Corp., New York City.

**Tubing Machine** ..... 28

Leonard Precision Products Co., Garden Grove, Calif., has introduced machine for squaring, burring, flaring, and beading ferrous and non-ferrous tubing. Working to either AC 811 or AND 10060 specifications, this device, the "Tube Master," has been designed to eliminate use of hand tools and dies.

**Pump Data** ..... 29

Engineering data on "H" series (capacities to 18 gpm.) continuous contact internal generated gear rotary pumps are available from manufacturer, Gerotor Mfg. Co., Baltimore.

**Tubing Purchasing** ..... 30

To facilitate placing of orders for steel aircraft tubing, Aircraft Scheduling Unit, Aircraft Production Div., WPB, Dayton, Ohio, has issued *Aircraft Tubing Purchasing Manual*, giving complete synopses of various specifications required for steel tubing, with a detailed explanation under each specification.

**Tool Specifications** ..... 31

Photos and specifications of Beryllium beryllium copper safety tools are contained in folder from Beryllium Corp. of Pennsylvania, Reading, Pa.

**Accident Prevention** ..... 32

Boyer Campbell Co., Detroit, has issued 144-page catalog of safety equipment.

**Power Transmission** ..... 33

Illustrated handbook, *Modern Mechanical Power Transmission*, from Cling


and delivery of these battleplanes, Goodyear Pennsylvania Motor Oil for safe lubrication.

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Surface Co., Buffalo, explains grouping of machines, engineering of drive components, and care of belts.

**Patented Fastener** ..... 36

Aircraft Parts Development Corp., Summit, N. J., has made preparations for quantity production of fastener patented by Dr. Edward L. Mack for use with removable engine cowlings.

**Adhesives and Coatings** ..... 37

*Special Coatings and Cements for War Industries*, leaflet of Union Bay State Co., Cambridge, Mass., lists coating products for use on barrage balloons, magneto parts and similar electrical equipment, gaskets, and engine mountings.

**Clamping Tools** ..... 38

*Toggle Action Clamping Tools* is catalog from Knu-Vise, Detroit, containing drawings and photos of toggle clamps, pliers, and vises.

**Plastic Parts** ..... 39

Illustrations of plastic parts, fabricated to close tolerances without use of molds, are contained in folder from Creative Plastics Corp., Brooklyn.

**Metal Band Saw** ..... 40

Pertinent parts and advantages of metal-cutting band saw, designed for easy set-up and operation by unskilled labor, are pointed out in folder from Johnson Mfg. Corp., Albion, Mich.

## NEW PRODUCTS

**Anti-Rust Compounds** ..... 41

Broadside from Black Bear Co., Long Island City, N. Y., explains uses and applications of two compounds designed to prevent rust on machine parts, castings, stampings, etc.

**Nitriding** ..... 42

Photos, graphs, and text in Catalog T-624 describe forced-circulation *Homo Method for Nitriding* developed by Leeds & Northrup Co., Philadelphia.

**Work Platforms** ..... 43

Construction of platforms made by Wolfe & Mann Mfg. Co., Baltimore, and their use in engine inspections on large planes are illustrated and diagrammed in booklet from this manufacturer.

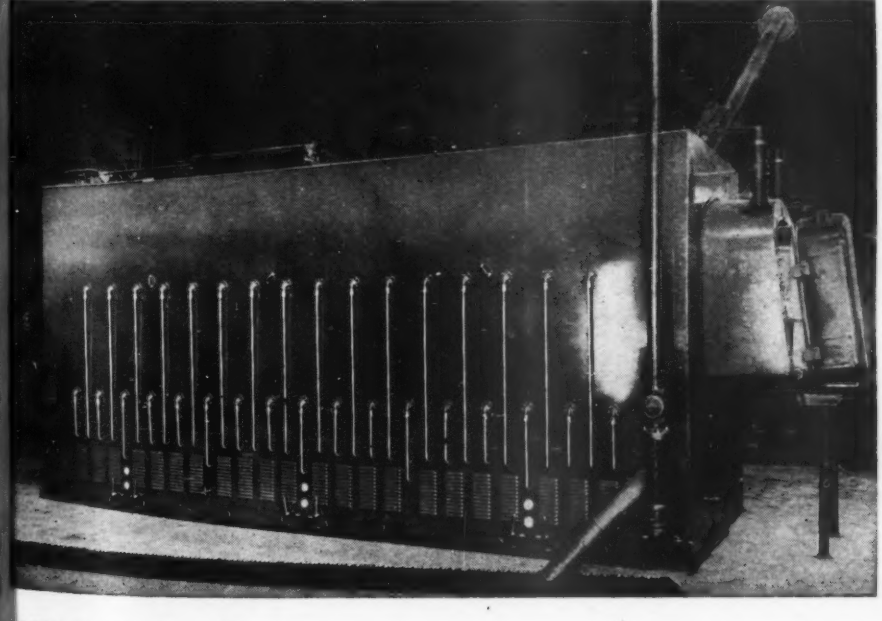
# Latest Machine Tools

**Small Miller** ..... 44

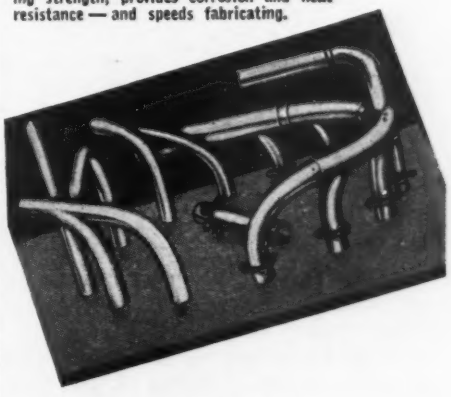
Tool room and production models of small size milling machine are now being offered by **Diamond Tool Co.**, Los Angeles. Engineering features include vertical collapsible pulley arrangement and one-shot spider-web lubricating device for table, saddle, and knee. Production model is equipped with rack and pinion feed to speed output.—AVIATION, *May*, '43.

**Heat-Treating Furnace** ..... 45

Called largest chemically-neutral atmosphere heat-treating furnace yet




In products like exhaust collector rings, this tubing saves weight without sacrificing strength, provides corrosion and heat resistance — and speeds fabricating.



*Check this*
**stainless tubing** *for*

**LIGHT WEIGHT**—The *uniform walls* of Carpenter Welded Stainless Tubing permit the use of lighter gauges without sacrificing strength. Then too, the strength-weight ratio of Stainless Steel often permits the use of fewer pounds of metal for the job.

**STRENGTH**—The high tensile strength of Stainless, and the weld that is chemically and mechanically analogous to the parent metal, provide a definite safety factor. Hydrostatic pressure tests, surface and tolerance tests are made regularly.

**CORROSION & HEAT RESISTANCE**—From aircraft fuel lines that must fight corrosion, to exhaust collector rings made to withstand terrific heat, Carpenter Welded Stainless Tubing keeps equipment on the job and helps to reduce maintenance.

**FASTER FABRICATING**—As tube shapes are natural design units, finished parts can often be made by merely flanging, swaging, expanding, etc. And because of the lighter gauges used, and uniformity from lot to lot, this tubing is easy to bend, cut or weld.

*here's help*

*with your design-engineering and fabricating problems. Carpenter's series of QUICK FACTS bulletins can help you get the most from Welded Stainless Tubing. They can help your new men become more familiar with accepted fabricating methods. A note on your company letterhead will start a series of QUICK FACTS bulletins on the way to you. Write us today.*

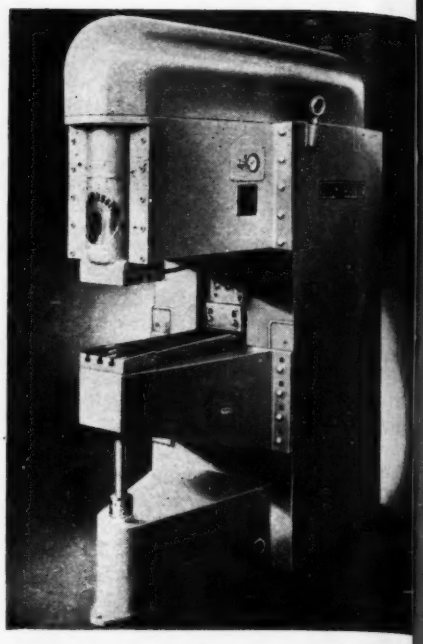
**THE CARPENTER STEEL COMPANY**
*Welded Alloy Tube Division, Kenilworth, N. J.*

Carpenter
WELDED
STAINLESS TUBING

built, new Litheo unit installed in large propeller plant has a capacity of approximately 3,000 lb. per hour and overall dimensions of 8x10x30 ft. Rail-roller system of muffle support compensates for expansion and contraction of muffle, which is 3x3x25 ft. and built to withstand working temperatures of 900 to 2,100 deg. F. Insulation 16-in. thick confines heat generated by 66 burners. Said to require no atmosphere adjustments because chemically-neutral atmosphere dispels contaminating gases and vapors, furnace is reported to deliver work requiring no cleaning, polishing, or de-scaling. Maker is **Lithium Corp.**, Newark, N. J.—AVIATION, *May*, '43.

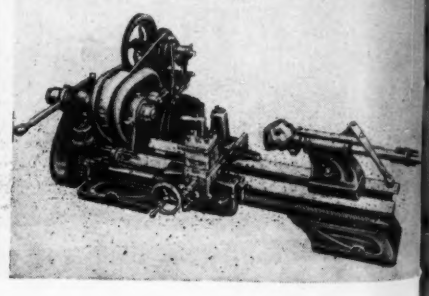
**Resistance Welders ..... 46**

Press and projection type resistance welders are available from **Progressive Welder Co.**, Detroit, in four sizes—light duty (illustrated), medium, heavy, and extra heavy—4 to 6 kva. capacities, and a variety of throat depths. Each model is provided with motor or air power; extra-heavy duty styles can be had with hydraulic power. Each capacity range has single basic frame designed to accommodate heaviest duty model in its range, thus permitting conversion to higher or lower capacities. All models have universal T-slot platens, vertically adjustable knees, and water-cooling manifolds. Welding heads have long box-type gibs, and transformers have water-cooled secondaries, shell-type cores, and pancake coils. Unit is designed for power supply of 50/60 cycles at 220, 440, or 550 v.—AVIATION, *May*, '43.



**Lathe-Screw Machine ..... 47**

**Atlas Press Co.**, Kalamazoo, Mich., is manufacturing production attachments to convert its F-series 10-in. lathes into hand-type screw machines for making small precision parts. Shown here is lever-type collet chuck, carriage turret with four-way and back-slide tool posts, tailstock turret for six operations, multi-stop attachment for gaging length of cut reversing switch, and spindle nose cap. Specifications: Collet capacity ½ in., swing over bed 10¼ in., 16 spindle



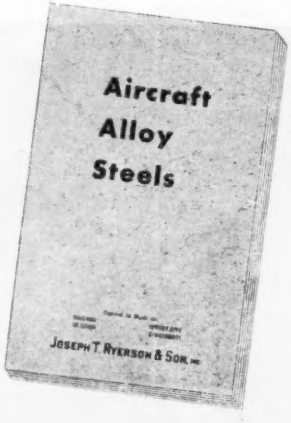

# Aircraft Quality Alloy Steels in Ryerson Stock at:

*CHICAGO — ST. LOUIS — CINCINNATI — JERSEY CITY*

Chromium-Molybdenum (X4130 & 4140) bars, both hot rolled and cold rolled in a wide range of sizes are carried at the Ryerson ACW warehouses, Chicago, St. Louis, Cincinnati and Jersey City. These steels are earmarked for the use of the aircraft industry and sub-contractors by the Aircraft Scheduling Unit of the Aircraft Production Board. The distribution of these steels is intended for the territories logically adjacent to these four plants although emergency shipments can be made to other parts of the country when requirements cannot be filled from local stocks.

*NEW BOOKLET*

A handy booklet for the aircraft industry. Contains: listing of available aircraft alloy steels; a condensed table of the Aeronautical Materials Specifications (AMS) that pertain to steel; tables of the Army Navy Specifications (AN-S) which cover the NE National Emergency Alloys that are acceptable for aircraft production; and conditions of sale, price and extras.




*Write for your copy today.*

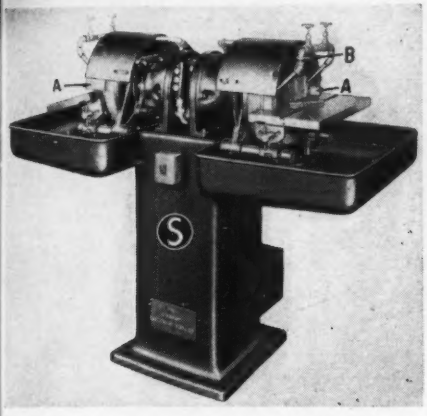
## JOSEPH T. RYERSON & SON, Inc.

Aircraft Alloy Steels are in stock at our Chicago, St. Louis, Cincinnati and Jersey City plants. Other Ryerson steels are available in over 10,000 different kinds, shapes and sizes.

speeds between 28 and 2,072 rpm., thread cutting range, right and left, 4 to 96 (standard), four bed lengths 18 to 36 in. between centers.—AVIATION, *May*, '43.

**Tool Grinder .....48**

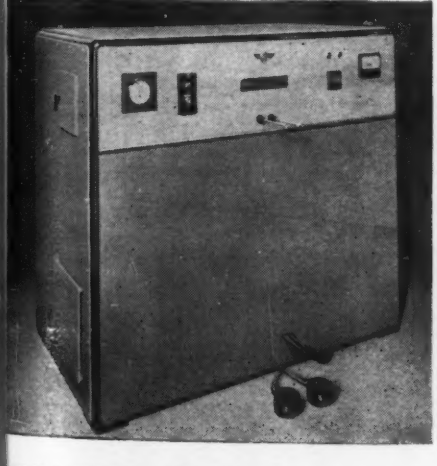
**Standard Electrical Tool Co.**, Cincinnati, has redesigned its 3-hp., 1,150 rpm., 14-in. carbide tool grinder to incorporate rigid mountings for work tables. Graduated tables can be angled



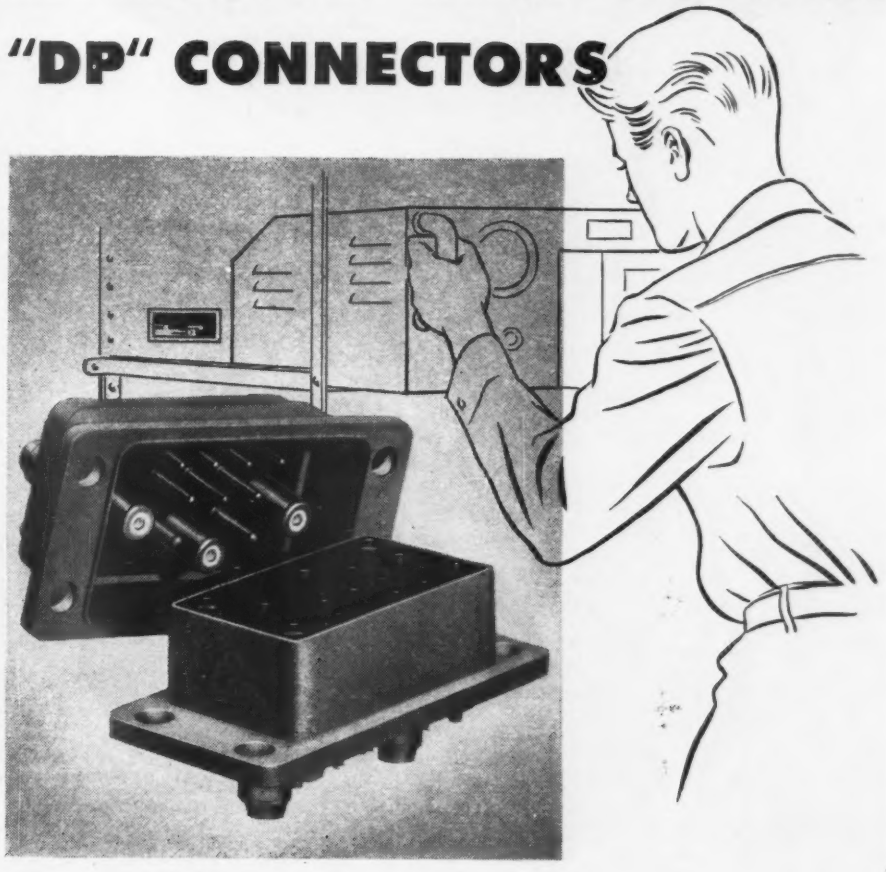

5 deg. toward or 30 deg. away from wheels. Other features are magnetic reversing starter and three-button switch, steel backing plate for mounting cup grinding wheels, and optional wet grinding attachment which is powered and controlled by individual motor and switch. Each wheel (see photo) is protected by splash guard *A* adjusted by hand screw *B*.—AVIATION, *May*, '43.

**Heating Unit .....49**

**Van Norman Machine Tool Co.**, Springfield, Mass., announces new induction heating unit, for surface hard-




# EXCLUSIVE WITH CANNON "DP" CONNECTORS

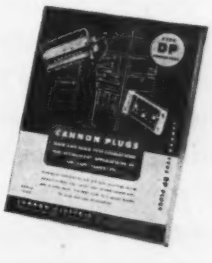


The creation of the "DP" Series of connectors, designed with rectangular shell for special application to rack and panel equipment, is *strictly* a Cannon development . . . carried out in collaboration with airline engineering personnel.

Originally designed for aircraft use, the "DP" family of connectors is finding wide application in many fields where space is limited . . . where varied circuits must be plugged in and out with a minimum of effort.

There are many styles of "DP" connectors. Among them the "DP-D" for rack type equipment which covers a maximum of thirty contacts. In this unit there are insert arrangements for taking 10, 15 and 40 ampere contacts, and many variations are possible.

**SEND FOR YOUR COPY OF CANNON BULLETIN ON "DP" CONNECTORS.** This 24-page bulletin gives complete data, photographs and dimensions of the various "DP" connectors. Drop us a line on your letterhead and we'll gladly send you a copy. Address Department L, Cannon Electric Development Co., Los Angeles, Calif.



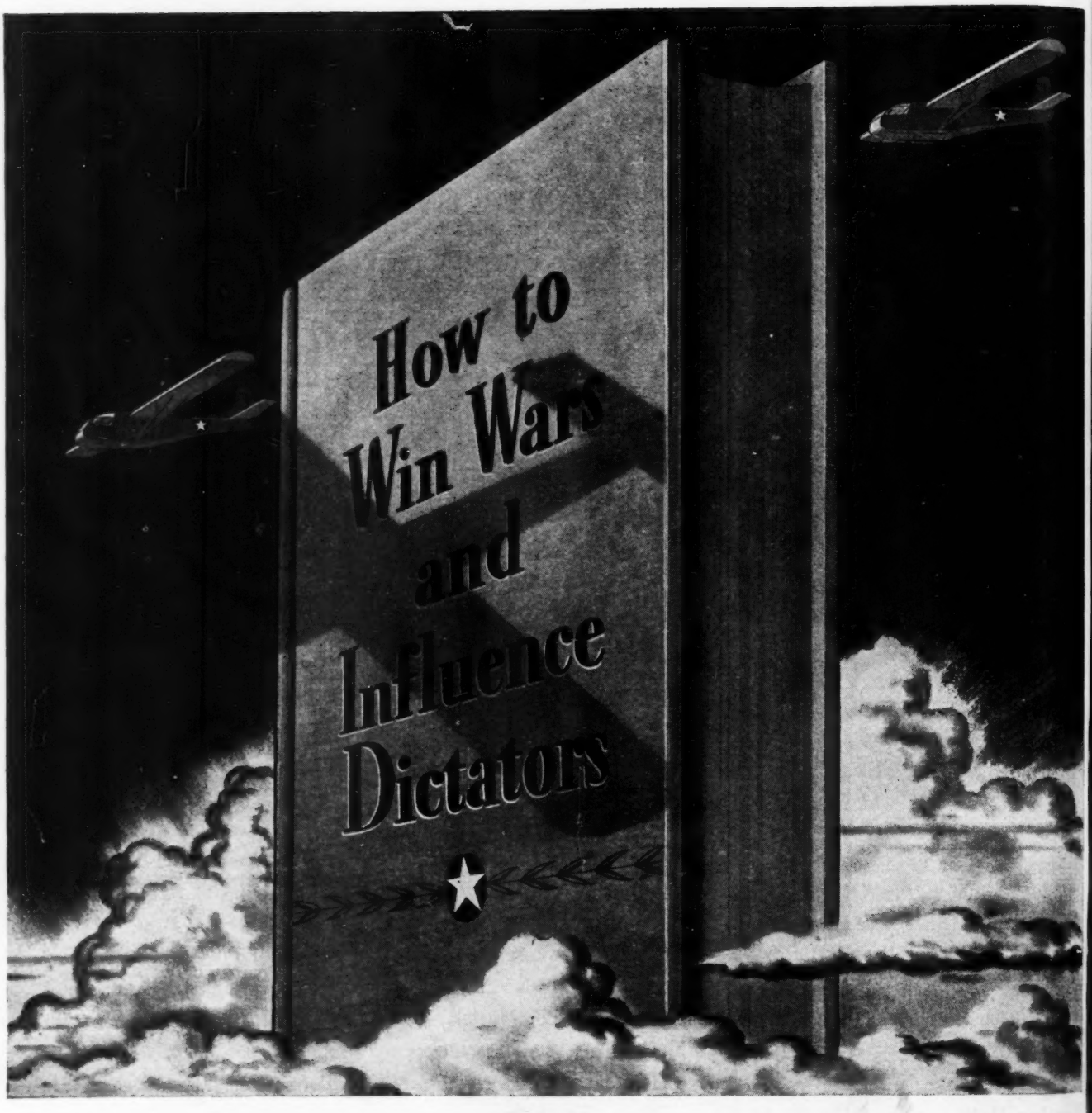

CANNON ELECTRIC

**CANNON ELECTRIC**

**Cannon Electric Development Co., Los Angeles, Calif.**

**Canadian Factory and Engineering Office: Cannon Electric Co., Ltd., Toronto**

***REPRESENTATIVES IN PRINCIPAL CITIES — CONSULT YOUR LOCAL TELEPHONE BOOK***




Somewhere on some front, a huge motorless ship silently settles behind an enemy outpost and from its bowels—on the double—swarms a squad of air-borne infantry full of mustard and mayhem. That's *Waco's* contribution to this war . . . nine- and fifteen-place gliders . . . designed by *Waco* . . . built by *Waco* and more than a dozen other prominent plane manufacturers.

On another front, a thousand miles away, a flyer hits the silk. Thanks to a bare-legged stenographer in Indianapolis or Philadelphia . . . he'll live to fly again. And somewhere at sea, a sailor clings to his tiny life-raft. Thanks to someone's rubber tires . . . *your* rubber tires . . . he'll sail again to Murmansk.

That's the way it is in this war. We all have a hand in its winning . . . and when its history is finally written, each page will bear the imprint of some one of us. We can think of no title for this story so appropriate as "How to Win Wars and Influence Dictators" . . . no dedication so fitting as "To 130,000,000 Americans."

WACO AIRPLANES

THE WACO AIRCRAFT COMPANY • TROY, OHIO

cning, brazing, and soldering, available in 16 and 32 kw. sizes. After operator has connected proper heating coil and set heat and quench style, machine works automatically. To change from one type of work to another, operator changes work-holding fixture and heating coil and resets cycle.—AVIATION, *May*, '43.

NEW PRODUCTS

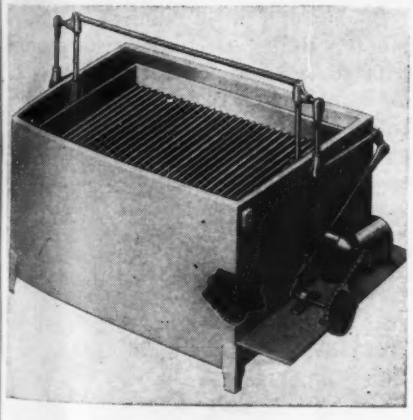
**Carbide Tool Grinder.....50**

With V-belt drive to dampen motor vibrations, new model 4-B combination chip breaker and cup wheel grinder by **Hammond Machinery Builders**, Kalamazoo, Mich., is also provided with brake to stop wheels quickly when reversing on single phase current. Chip breaker side has precision tool setting for diamond wheel groove grinding. Ball bearing spindle is permanently grease-sealed. Side holding silicon carbide cup wheel is also equipped with 8x14 in. table which can be tilted at angles between 25 deg. below to 15 deg. above horizontal. Unit comes with standard ½-hp. motor designed for 1,750 rpm. on 110 v., single phase, 60 cycle current, but other motors are available.—AVIATION, *May*, '43.

# Shop Equipment & Accessories

**Parts Cleaner.....51**

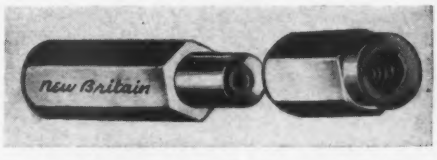
**Sturdy-Bilt Equipment Corp.**, West Allis, Wis., announces improved small metal parts washing unit, known as



Simplex, which is available in three sizes: 36x24x36 in., 130 gal.; 48x36x36 in., 265 gal.; and 60x48x36 in., 450 gal. Tank is insulated, and cleaning solution may be heated by steam, electricity, or gas. Parts to be cleaned are loaded into tray which is raised and lowered in solution by electric motor.—AVIATION, *May*, '43.

**Stud Loosener.....52**

To free rusted or corroded studs, this new device from **New Britain Machine**




**Co.**, is screwed onto stud, its chamber is filled with penetrating oil, and tool is then tapped down with hammer. Blow forces oil into sticky threads. Tool weighs ½ lb., comes in three sizes, ⅜-24, 7/16-20, and ½-20 in.—AVIATION, *May*, '43.

**Cleaning Tank.....53**

**Aeroil Burner Co.**, West New York, N. J., has introduced Dipmaster, Jr.,

**• Announcements of new machine tools, shop equipment, and accessories are invited for inclusion in these columns. In writing, emphasis upon aviation industry applications of newly-marketed items is desirable, and wherever possible, glossy-print photos should be enclosed for illustration. Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City.**

**Where Precision Built Parts are Vital**

THE precision with which a plane roars through the sky has its beginning in many widely separated plants, turning out small parts and special equipment.

Production of small parts for aircraft needs, accurately machined to exact measurements, is a service FENN has rendered for many years. Their long experience in building special machinery has given them a sound knowledge of design and production.

Keep the name FENN in mind for machines and tools, design and development, and sound engineering counsel when the world once more turns to industrial peace-time projects in the days ahead.

FENN

THE FENN MFG. CO.
HARTFORD, CONN.
ESTABLISHED 1900

small, portable, electrically-heated tank for immersion cleaning and degreasing of metal parts. Tank, mounted on four casters, two swivel, two rigid, has maximum capacity of 15 gal. of solution which can be drained off by cock at bottom. Heating element, available for 110 or 220 v. a.c. or d.c., can be removed from rear head of tank, where it is mounted for protection, when cleaning or using cold solution. Heat is measured and controlled by bi-metal thermometer with range of 100 to 600 deg. F. and thermostat for manual or automatic regulation between 100 and 550 deg. F. Inner liquid-containing tank is insulated, and average time for raising temperature of solution from cold start to boiling is 1¼ hr.—AVIATION, *May*, '43.


# A BLIND RIVET

# FOR PRIMARY STRUCTURES

The Cherry Blind Rivet does its work very effectively by means of a mandrel passing through the rivet. A pulling force applied to this mandrel forms a head on the blind side and expands the rivet shank.

The self-plugging Cherry Rivet is used successfully in primary aircraft structures because the expanded rivet develops nearly the full unit strength of an equivalent joint employing a conventional solid rivet.

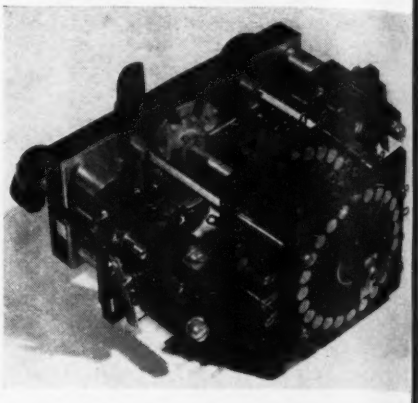
**16-PAGE HANDBOOK,** giving diagrams, dimensional sketches and photographs covering the Cherry Riveting Process, is available on request. Write for your copy today. Address Department 1, Cherry Rivet Company, Los Angeles, California.

CHERRY RIVETS, THEIR MANUFACTURE AND APPLICATION ARE COVERED BY U. S. PATENTS ISSUED AND PENDING.

Cherry Rivet Company
LOS ANGELES, CALIFORNIA


**Floodlight Switches.....54**

New line of switches, including runway selector and brightness selector, have been developed by **Westinghouse Electric & Mfg. Co.**, East Pittsburgh,



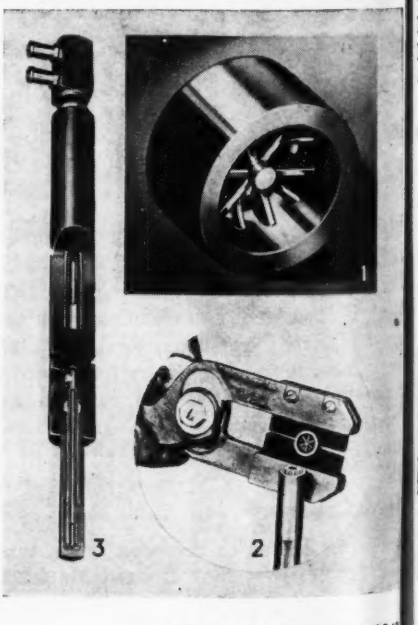
for airports. Mechanically interlocked with selector switch are two double-pole, single-throw, preset switches wired to permit operation of runway contact lights, any group of floodlights, and group of floodlights and corresponding contact lights. Brightness selector switch has five brilliancy settings for contact lights.—AVIATION, *May*, '43.

**Spare Parts Box.....55**

**Stackbin Corp.**, Providence, R. I., is manufacturing variety of all-welded steel boxes for producers who ship spare parts along with finished products.—AVIATION, *May*, '43.

**Welding Electrode.....56**

Saving of copper required for resistance welding electrodes is reported with specially-tipped refrigerated electrodes made by **Frostrode Products**, Detroit. Machining and hand dressing are eliminated because tips can be replaced cheaply. Integral fins (Fig. 1) stimu-



## NEW PRODUCTS

late flow of liquid coolant. Tip is replaced with special electric pliers (Fig. 2) which seal low-melting-point solder. Electrode (Fig. 3) fits into any standard holder, water circulation extending to adapter and coolant serving remaining distance to point.—AVIATION, *May*, '43.

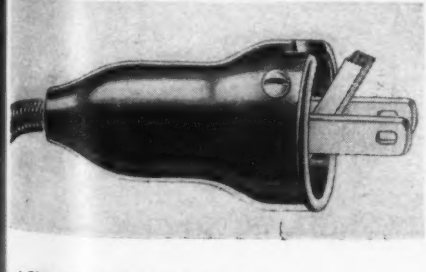
### Masking Paper ..... 57

New masking paper with one or both edges gummed to eliminate necessity of handling both masking paper and tape

is announced by **Adhere, Inc.**, Los Angeles. Available in 200-ft. rolls of 3, 6, 9, 12, 18, 24, and 36-in. widths, paper has strip of gummed surface protected by a cover tape. Center openings are large enough for operator to carry all but wider rolls on forearm, as shown in photo, leaving both hands free to remove protecting tape and apply paper.—AVIATION, *May*, '43.

### Circuit Breaker ..... 58

Actuated by heat, circuit breaker plug made by **Hopax Industries**, Chicago, is designed to protect individual accessories or lights on same circuit. Sudden surges do not trip breaker. However, this time-delay feature is controlled by



New low-priced duplicating masters made of paper now open the way to many new uses for existing Multilith Equipment.
DUPLIMATS GIVE CLEAR BLACK ON WHITE REPRODUCTIONS, WITH OTHER COLOR COMBINATIONS AS DESIRED. THEY ASSURE PERMANENCE AND LEGIBILITY ON A WIDE VARIETY OF PAPER STOCKS.
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Few copies or many copies
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EASILY prepared — DUPLIMATS are as easily handled by typists as any sheet of ordinary paper. Nothing strange or mysterious to learn. Type on them, write on them with pen and ink, draw on them with crayon pencil, brush or ruling pen. Use drawings, maps, graphs, ruled tables, sketches, cartoons—almost anything you can put on paper. In case of error, erase and correct as you do on other paper.

Simple, quick, economical—and every copy is an actual facsimile of the master.

In addition to the use of these new DUPLIMATS, there are other ways to increase the services of your Multilith and Multigraph equipment. For more ideas, send for a trained Multigraph representative. Call or write nearest Agency, or write—

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*Left: Laying corrugated steel mats. Inset: Fastening mates with handy Spring Clips.*

Photos by U. S. Army Signal Corps.

# SPRINGS FOR AIRPORTS—
## NEW GUINEA STYLE!

***Recipe For A Portable Landing Field—Uproot trees, tear away undergrowth, plow earth level, lay steel mats, link together with Muehlhausen Spring Clips.***

Portable landing fields are necessary so that airplanes may be the spearhead of attack. A necessity which does not allow much choice in location. A tangled jungle or a tide-swept beach must often serve. And, most important—the runway must be laid with lightning speed.

The solution to this problem is the result of typical American ingenuity. Steel mats, not unlike enormous door mats, are laid in sections and connected with spring clips made by Muehlhausen. These tight-locking clips are serving admirably to absorb the tremendous shock and strain of heavy bombers as they land and pull their weight to a sudden stop.

This unusual spring application is one of many ways in which Muehlhausen is contributing to our nation's war effort.

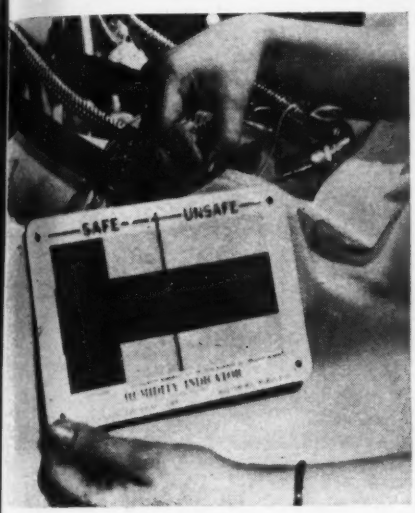
MUEHLHAUSEN SPRING CORPORATION
740 Michigan Ave., Logansport, Indiana

**MUEHLHAUSEN**
**SPRINGS**
EVERY TYPE AND SIZE

magnitude of overload: 50 percent will trip in an average of 6 min., 150 percent in 10 sec. To reset, lever between plug forks is merely raised and lowered. —AVIATION, *May*, '43.

**Moisture Indicator** ..... **59**

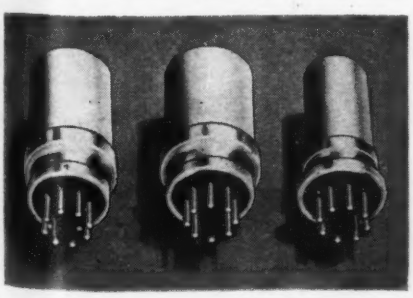
For detecting damaging moisture in packages during shipment, **Celanese Celluloid Corp.**, New York City, has devised Lumarith window and four-color




paperboard frame indicating danger points in color. As moisture increases, Protek-Sorb hygroscopic crystals behind window change color—deep blue to pink—and danger can be judged by matching color with predetermined danger points on colored card.—AVIATION, *May*, '43.

**Electrolytic Condenser** ..... **60**

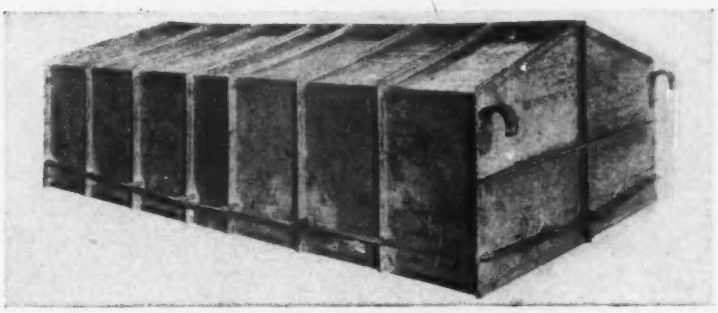
For elimination of low frequency ripples (2 to 100 cycles), **Sprague Specialties Co.**, North Adams, Mass., reports that dry electrolytic condenser it manufactures is easily mounted and removed and has life expectancy sufficient to make soldering or welding into units practicable.—AVIATION, *May*, '43.



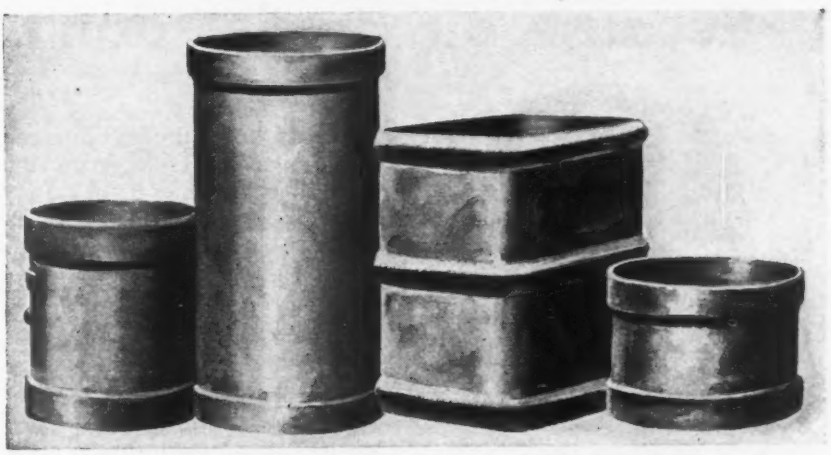

# *Less Maintenance and Greater Production*

## WITH THESE PRESSED STEEL COMPANY PRODUCTS

*Annealing Tubes made to specification. These tubes are 20 ft. long, 20 in. in diameter and will give many added hours of service.*



*Annealing cover made of special alloy. Lighter in weight, easier to handle. Will outlast the average cast alloy equipment by many hours.*

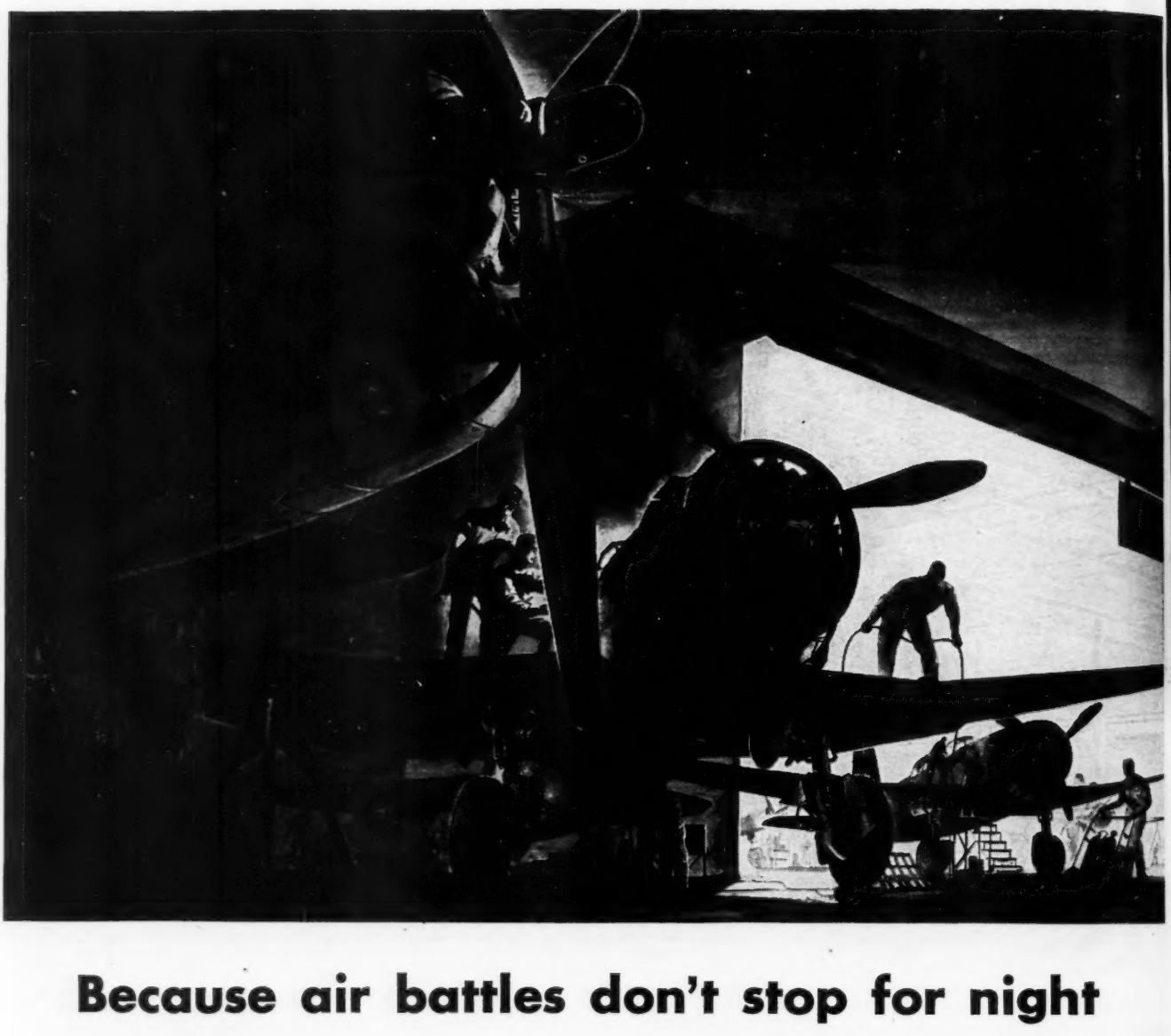


*Carburizing Boxes, seamless drawn covers and bottoms.*

**THE PRESSED STEEL COMPANY**
of WILKES-BARRE, PENNSYLVANIA

DETROIT: 337 Curtis Building • TOLEDO: 1914 Vermont Avenue
CHICAGO: 205 Engineers Building • NEW YORK: 254 West 31st Street
TORONTO, CANADA: A & M Accessories Ltd., 19 Melinda Street

**PRESSED STEEL COMPANY PRODUCTS:** Carburizing and Annealing Boxes, Thermocouple Protection Tubes, Seamless Steel Cylinder Caps, Seamless Steel Neck Rings, Welded Alloy Tubing for High Temperature and Corrosive Application, Radiant Tubes, Inner Covers and Base Sheaths for Steel Mills



# Because air battles don't stop for night

*HAVE YOU A PICTURE of what tonight will be in the skies over the world?*

*Every minute tonight, some squadron of young U. S. pilots will lift their wings from a darkened field. They're starting out with grim confidence.*

*It will help them if we at home get clear on where the stupendous U. S. air program now stands*—and on the place where each of us can fit into that plan and help make it go forward faster.

*As aircraft designers and engineers, the "Northrop group" is working night and day under that plan. Northrop submits here some facts on what's going on.*

. . .

**What kind of planes is the U. S. building?** This is a new kind of air war. In it the old-style "all-purpose" fighting plane isn't good enough. Today, one new plane may be a champ at what are called "low altitudes". But *because* it's so good close to the ground it isn't good enough 5 miles up in the sky.

The way to be best near the ground, and up high, and every place in between, is to have many different kinds of pursuit planes. That's what America is creating day and night—ALL kinds—including improvements on fighters already battle famous and deadly new ones you've not yet heard about. And plenty of each kind.

It's the same with bombers. In some areas we need bombers that will carry "block-busters" thousands of miles and come back home safe. In other areas another kind is better—bombers that will carry still bigger loads but have less flying range.

So here again the answer is many kinds of bombers. That is what the U. S. A. is building—and at a speed no nation ever dreamed of before.

. . .

**What can a person do to help?** *Every rivet in an airplane costs about 3 cents to drive into place. There are 600,000 rivets in one four-motored bomber. So, when you buy an $18.75 war bond you drive 625 rivets. Maybe that's enough rivets to hold a wing in place after a Jap shell has torn it, enough to get some boys safe back to their field after a night in a war-torn sky.*

**NORTHROP AIRCRAFT, Inc.**

NORTHROP FIELD, HAWTHORNE, CALIFORNIA • MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

## Metal Coating..... 61

Armor-Vit is name given new metal coating by its developer, **Chicago Vitreous Enamel Product Co.**, Cicero, Ill. Derived from oil-bearing halloysite in form of alkali alumina silicate, coating is applied to steel or iron by spraying or dipping, and curing is best done in

indirect-fired, air-circulating oven between 750 and 800 deg. F. Resulting finish has high resistance to heat, weather, acids, and other chemicals as well as being insoluble in water. Top part of exhaust pipe (illustrated) was coated with product. After five months exposure to weather, manufacturer reports that only uncoated bottom portion (being held in fingers) rusted.—AVIATION, *May*, '43.

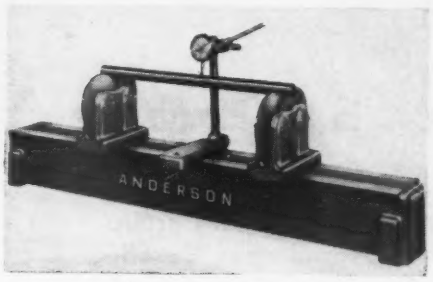
## Feeding Fixture..... 62

Unit combining feeding and holding, while drilling or tapping, with reported ejection rate of from 3,000 to 5,000 pieces per hour, is this semi-automatic disk-feeder developed by **Mead Specialties Co.**, Chicago. Fixture illustrated has adjustable hopper for round, square, rectangular, or oval blanks from 1 to 3 in. across widest point and thicknesses of $\frac{1}{8}$ to $\frac{3}{4}$ in. Heat treated ram and

anvil have V-notches and are serrated to center and hold work, which is changed by pressing foot pedal which controls recommended pressures of 80 to 125 psi. Cylinder has 3-in. stroke, delivers four times line pressure. By removing hopper device can be used as air-operated, hand-fed, drill press vise. Special attachments are available for small cylindrical work.—AVIATION, *May*, '43.

## Shafting Checker..... 63

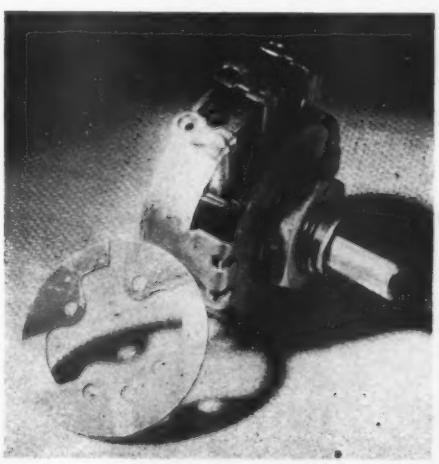
**Anderson Bros. Mfg. Co.**, Rockford, Ill., have developed device (see photo) for checking straight shafting, tubing, or pieces having same diameter at both ends. Work is mounted on end disks,




which rotate on sensitive ball bearings for checking under gage. Checker illustrated handles work up to 36 in. but larger units can be supplied.—AVIATION, *May*, '43.

## Resistive Coatings..... 64

Developed to give high resistance permanence, immunity to climatic con-



ditions, and wearing qualities to wire winding, new resistive coating for potentiometers and rheostats developed by

★ **Precious lives at stake—that was the predominant thought in the minds of Clarostat engineers while developing this split-winding power rheostat now used for a vital fire-control function in our fighting planes.**

**More specifically: 330° total rotation. Two resistance sections of matched resistance, equally disposed about a center section of virtually zero ohmage. Smooth transition from one section to another. Control must operate with very low torque and yet with positive contact pressure regardless of extremes in temperature, vibration, orientation.**

**This new control was produced in a few days, despite a new mold, new rotor and spring, three-winding strip. Today it is standard equipment. Typically a Clarostat assignment—and solution.**

ARMY E NAVY

★ *Send your problem to . . .*

CLAROSTAT Controls and Resistors

**CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.**

*All are included* **in the Plomb Line**

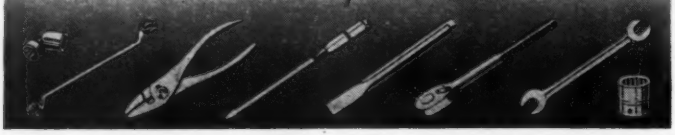
**In Plomb's complete line of supreme quality hand tools for all industries, the socket and attachment group alone includes hundreds of kinds and sizes. Equally complete—equally outstanding in quality—are all other types of tools that bear the famous Plomb name.**

**Their excellence has made them the choice of professional mechanics—has resulted in such gigantic demand that 36 separate factories operate night and day to fill war needs. Thus, Plomb tools in ever-increasing volume are available thru dependable dealers all over the country to help make weapons faster and better—and to maintain those weapons at peak efficiency.**

**In addition, if you need special tools for special war needs consult Plomb. And remember, for regular tools call the Plomb dealer in your neighborhood.**

PLOMB

*Fine Hand Tools for All Industries*



PLOMB TOOL COMPANY

LOS ANGELES ▽ CALIFORNIA


## NEW PRODUCTS

**Clarostat Mfg. Co.**, Brooklyn, N. Y. is laid upon bakelite base, giving hardness and smoothness. During production, new element is treated with heat and chemicals to stabilize composition and temperature and humidity characteristics.—AVIATION, *May*, '43.

### Perspective Drawing..... 65

To enable inexperienced mechanics to visualize and read blueprints, **Craftint Mfg., Co.**, Cleveland, is marketing "Doubletone" drawing board paper on which artists can shade-in depth, roundness, and other dimensions. Perspective drawing results because Doubletone has two tones, invisible to the eye, which can be "developed" for engraving, at no extra expense, by application of a special transparent liquid. Material has been officially approved and is being introduced into war training courses. Maker will send samples to manufacturers having a real or potential interest.—AVIATION, *May*, '43.

### Document Duplicator..... 66

**American Photocopy Equipment Co.**, Chicago, is marketing machine to duplicate printed documents, letters, and blueprints without tracings. Simplicity of construction and principle is said to permit operation of machine by unskilled help with only a few instructions.—AVIATION, *May*, '43.

**They work together better . . .**
**because they can talk together**

From a thousand feet up
The burning airdrome
Looks like
A "pushover" . . .

But
When you get
Right down to earth
It turns out to be
Anything but.

Suddenly the trees
To the right
Start throwing lead —
And your men
Are still hanging
Like clay pigeons
In their harnesses.

* * *

What a break
That you're equipped
With a
Two-way
Radio.

What a break
That you can tell your trouble
To a friendly
Fighter plane.

* * *

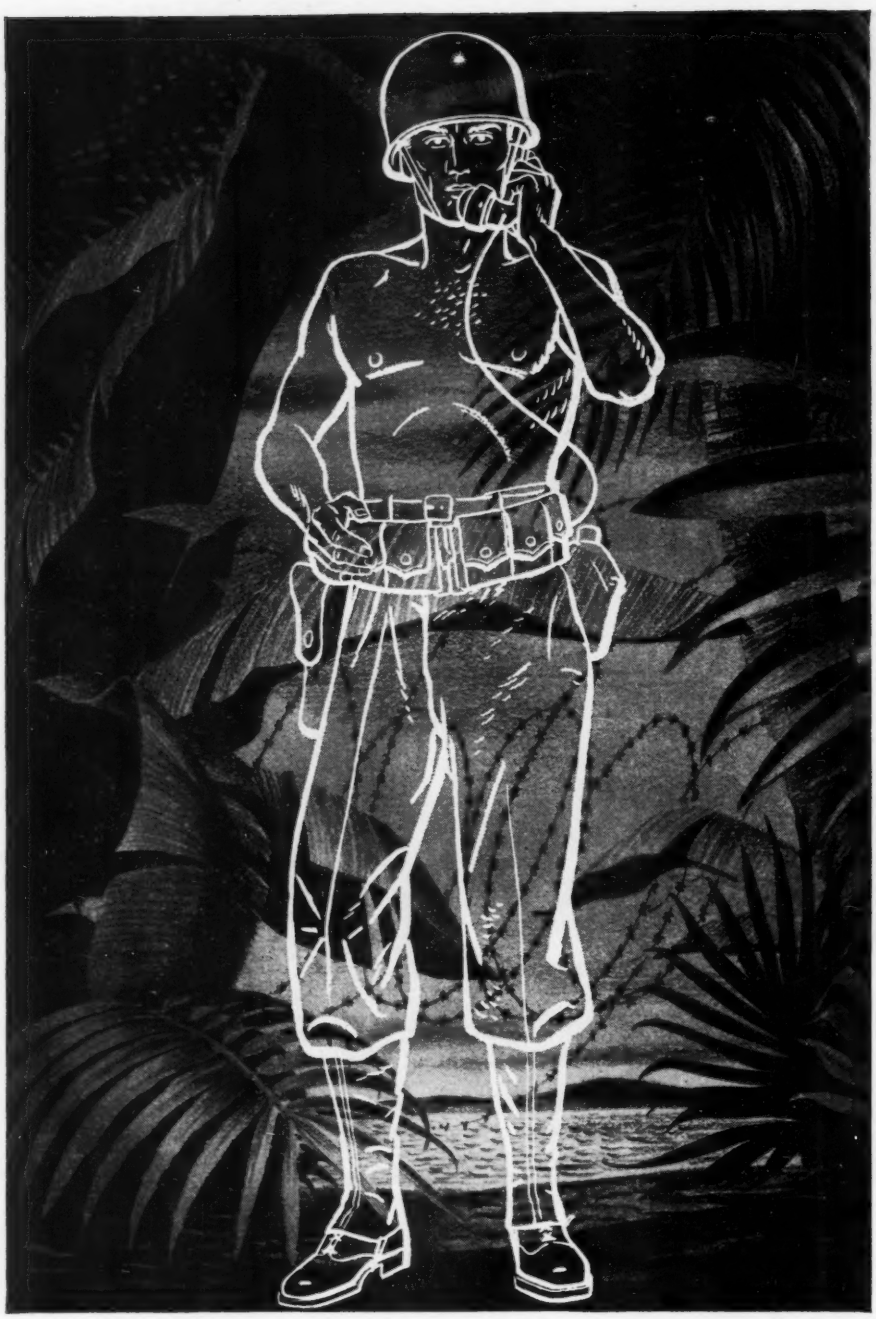
Today, communication equipment
Designed and manufactured
By I.T.&T. associate companies
Is helping Uncle Sam's fighting forces
Work together
On land, sea and in the air . . .

Tomorrow, the broad experience
Of I.T.&T.
In the field of communications
Will help build a better world
For every man.

**INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION** *67 Broad St., New York, N. Y.*

**I T&T**

*Manufacturing Associate:*
FEDERAL TELEPHONE AND RADIO CORPORATION



**Wherever man goes** . . . even when he's slashing through primeval jungle in some remote corner of the South Pacific, he is not alone, thanks to the existence of the two-way radiotelephone. In tomorrow's world, this new medium of communication will become an active part of your business and social life. When hostilities cease you can look to Jefferson-Travis for the finest radiotelephone equipment made. As pioneers in this field we have developed new and exclusive improvements for this electronic achievement. Today they are employed by the United Nations everywhere—tomorrow they will be yours!

**JEFFERSON-TRAVIS**

**RADIOTELEPHONE EQUIPMENT**

NEW YORK · WASHINGTON · BOSTON

## NEW PRODUCTS

**Starting Booster** ..... 67

Here, trailer unit has 19-hp. four-cylinder aircooled gasoline engine hooked

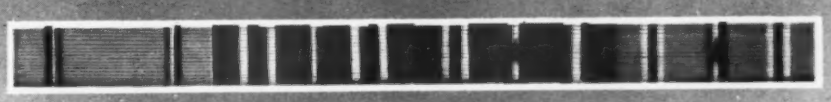
to a generator to provide up to 500 amp. at 12 and 24 v. for starting aircraft engines. Maker is **Lister-Blackstone,** Milwaukee. A pair of 24-v. floodlights mounted on unit make it suitable for night operations. Side tool boxes contain cables and accessories.—AVIATION, *May,* '43.

**Rivet Bucker** ..... 68

Simultaneous bucking and riveting is possible with this automatic bucker announced by **Aero Tool Co.,** Burbank, Calif. Weight of bucker with 22-in. throat is 14 lb. and with 36-in throat, 16 lb., including rivet gun. On horizontal work, rivets can be pre-loaded; on vertical, pre-loaded and tapped.—AVIATION, *May,* '43.

LOCKHEED P-38 *LIGHTNING*

*Campaigner*



AMERICAN DEFENSE SERVICE (PRIOR TO PEARL HARBOR) · AMERICAN THEATRE CAMPAIGN (OUTSIDE CONTINENTAL U. S.) · EUROPEAN-AFRICAN-MIDDLE EASTERN CAMPAIGN · ASIATIC-PACIFIC CAMPAIGN

*all with*

ELECTRIC **CURTISS** PROPELLERS

*For Continuing Achievement*

# A STAR FOR WESTON

## *—evidence that the vital instrument situation rests in good hands!*

A star now adorns the ARMY-NAVY "E" pennant awarded to WESTON just 6 months ago . . . the first such pennant awarded in this highly specialized instrument field.

It's a star that has *real meaning*. Because, from the very beginning of our defense period, the responsibility for producing the vast quantities of instruments vital to the success of our country's efforts, has rested largely on the instrument leader.

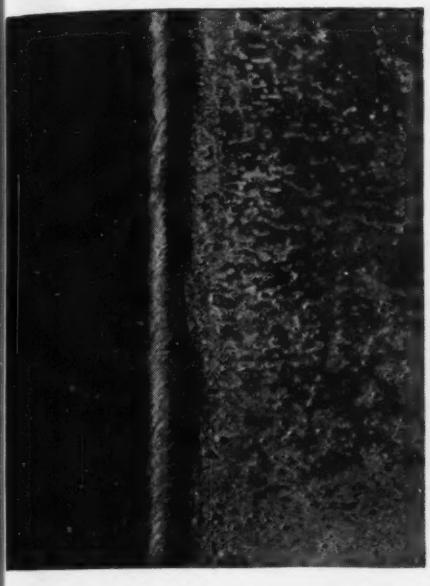
This star signifies that the responsibility *rests in good hands*. "The men and women of the WESTON Electrical Instrument Corporation," writes the Chairman of the Navy Board for Production Awards, "have achieved a signal honor by continuing their splendid production in such volume as to justify this award . . . indicating their solid determination and ability to support our fighting forces with equipment necessary for victory."

But a great instrument task still remains . . . before victory is ours. So WESTON workers continue reaching for new goals . . . with the same determination, the same painstaking devotion to the quality ideal, responsible for WESTON'S *continuing leadership* in the instrument field.

**WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, NEW JERSEY**

### Welding Spatter ..... 69

Accompanying photo from **Midland Paint & Varnish Co.**, Cleveland, illustrates use of firm's No-Spat to prevent adhesion of welding spatter. Left side



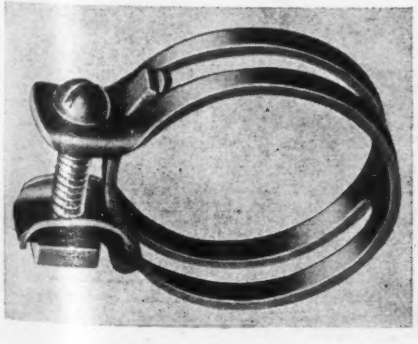
of weld was brushed with product and spatter was wiped away without grinding or chipping. Manufacturer reports product fuses with molten metal, maintains maximum tensile strength, and saves rod metal.—AVIATION, *May*, '43.

### Nylon Plane Tire ..... 70

**United States Rubber Co.**, New York City, reports nylon construction of new type airplane tire as far stronger than similar fabrication of rayon or cotton.—AVIATION, *May*, '43.

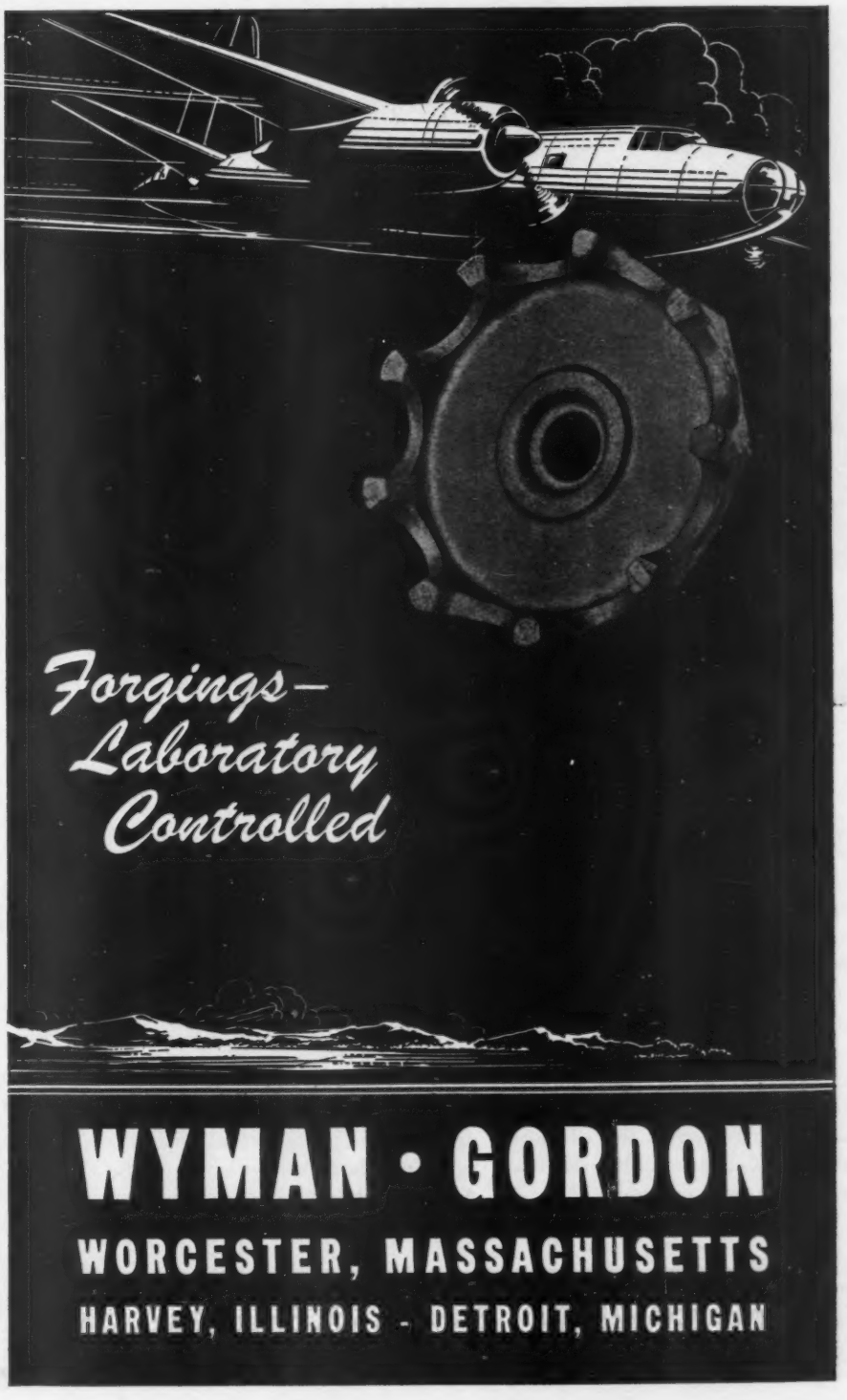
### Hose Clamps ..... 71

Listed as features of Sure-Grip clamps, made by **J. R. Clancy**, Syracuse, N. Y., for steam, oil, and air pressure and suction hoses, are perfect circle formed of heavy steel, separate galvanization of bolts and nuts to prevent rusting inside nut, and prevention of raw edges through process of galvanizing them after clamps are formed. More than 100 styles and sizes are available up to 6½-in. inside diameter, with larger dimensions supplied on order.—AVIATION, *May*, '43.



### Hydraulic Pumps ..... 72

Available in three standard sizes, 2½ to 12, 13 to 30, and 37 to 60 gpm., new constant-delivery hydraulic vane pumps produced by **Hydra-Motive Division**, Detroit, have maximum continuous operating pressures of 1,250 psi. and overload of 2,000 psi. According to manufacturer, patented dual vanes counterbalance total outward pressure, prevent overheating and wear. Bevel in each vane is designed to allow oil under pressure to reach outward edge of each pair of vanes. Another feature, "compound pumping," said to increase volume of delivery as much as 30 percent, employs ends of vanes nearest shaft as piston pump. On intake, cycle oil is trapped in vane slot. On outlet, when



# AT LAST...AUTOMATIC S-O-S FOR MEN ADRIFT AT SEA

Now it can be told...the story of a pint-sized Bendix transmitter that is saving the lives of American pilots adrift and in distress at sea. Thousands of planes have already been supplied with this equipment.

The transmitter is entirely automatic—power for the set as well as for a signal light is generated through a hand crank...while a built-in keying device sends out international S-O-S signals over an area of more than 40,000 square miles. Manual keying also can be used.

Around the world men in uniform affectionately call this Bendix set the "Gibson Girl"—its wasp-like waist fits between the knees for easy operation. The case is water-tight and is equipped with a parachute for any emergency. Both a kite and a balloon are packed with the set for raising the aerial in any weather.

As part of the great Invisible Crew, Bendix Aviation, Ltd., is justly proud of this development—exclusively designed and being manufactured by us in collaboration with the U. S. Army Signal Corps. Bendix Aviation, Ltd., North Hollywood, California.

***Join the Order of Gibson Girls.*** If you owe your life to this equipment, or know of someone who has been saved, write today for credentials in the most exclusive club in the world—the order of Gibson Girls.

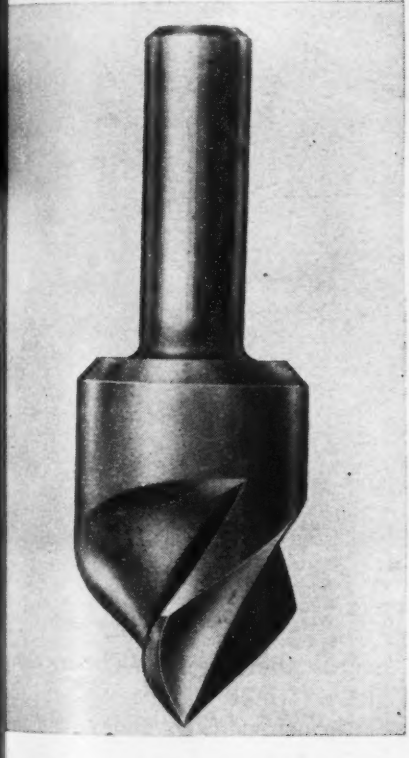
THE INVISIBLE CREW
Precision Equipment by
Bendix
AVIATION CORPORATION

## NEW PRODUCTS

anes are forced back toward shaft by change in contour of stator, oil is forced out of vane slot into port which connects with main outlet. This sequence, occurring twice during each rotor revolution at diametric sides, is stated to cancel out forces on shaft bearings. All three pumps are available with foot mountings; two smaller sizes also have motor adaptor mountings. Approximate diameters and lengths of three models, including shafts, are 3x6⅞, 4¼x8, and 4¾x13 in.—AVIATION, *May*, '43.

### Countersinks and Bores.....73

**Schrillo Aero Tool Engineering Co.**, Los Anegles, reports refinements in design and manufacture of its spiral fluted countersinks and counterbores making



possible repeated sharpening of tools without loss of cutting efficiency or impairment of superior chip clearance.—AVIATION, *May*, '43.

### For Protecting Plastics.....74

From a petroleum base, **E. I. duPont de Nemours & Co.**, Wilmington, Del., has developed synthetic rubber cement for attaching paper protectors to plastic enclosures while planes are being manufactured.—AVIATION, *May*, '43.

**doesn't mean *neglect* ...even with Bus Duct**

So simple, so sturdy, so soundly engineered is Bus Duct that only a minimum of maintenance is needed. Yet that *minimum* is important.

A thorough inspection and routine service once a year are usually enough to keep Bus Duct at top efficiency. But more frequent attention pays, especially where the system may be subjected to moisture, salt-laden air or corrosive fumes.

***Here are some points to watch:***

- **Keep hanger bolts and bus bar connections tight.**
- **See that nothing is left in the duct that does not belong there.**
- **Clean out metallic dust and dirt periodically with an air hose.**
- **Watch for insulation abrasions on cables.**
- **Check plugs for loose fuse clips, defective contacts and faulty cable connections.**

Maintenance is a real, if unspectacular contribution to the war effort.

Bus Duct can really "take it." Given ordinary, commonsense care, it will keep on delivering power and light under the heaviest loads, at lowest possible maintenance cost.

**BUY MORE WAR BONDS • SALVAGE ALL SCRAP METAL**

*Send for descriptive Bulletin No. 427*

**BULLDOG**
**ELECTRIC PRODUCTS CO.**
**Detroit, Michigan**

BullDog Electric Products of Canada, Ltd., Toronto, Ontario

**Field Engineering Offices in All Principal Cities**

**MANUFACTURERS OF Vacu-Break Safety Switches, Saf-T-oFuse Panelboards, Circuit Master Breakers, Switchboards, Bus Duct Systems — FOR LIGHT AND POWER.**

NOT all war assignments are in far-off places. Nor are they all on battlefields.

There's many a vital war assignment right within the continental bounds of the United States . . . in the plants and factories that turn out the implements and weapons of war.

Fleetwings' assignment, for example, is in Pennsylvania. Here, men and women build planes and plane parts to sweep the Axis from the skies.

How well Fleetwings' men and women are doing their job . . . how fast they are turning out the many wings, fins, ailerons, stabilizers, flaps, tail assemblies, fuselage sections, and hydraulic valves they're building . . . is evidenced by the Army-Navy "E" burgee that flies over Fleetwings' Plant Number One.

But the men and women at Fleetwings aren't satisfied merely to fill their war assignment. Even now, on Fleetwings' drafting boards, there are plans being completed which indicate that the battle being fought today, will not have to be re-fought tomorrow. With Victory, Fleetwings will be ready with the planes and plane parts to help win the Peace.

(Plant No. 1)

**FLEETWINGS**

*Division of Kaiser Cargo, Inc.*

BRISTOL • PENNSYLVANIA

FLEETWINGS

*pioneers with parts and hydraulic equipment*

*The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.*

**ONE OF FLEETWINGS'** newest time-savers is a sponge-rubber and hardwood roller to be used during taping operations. With this device the operator is able to keep his hands from continually being covered with finishing dope and to cut taping time nearly 50% over the conventional manual method.

**FLEETWINGS' HYDRAULICS DIVISION** got its original impetus because a certain hydraulic valve needed for the pioneer all-steel airplane, the Fleetwings "Seabird," could not be bought on the open market. From designing and building one valve, this division has now grown so large that it is producing hydraulic valves that control the landing gear, bomb doors and wing flaps on many of America's fastest fighting planes.

**VICTORY GARDENING,** to help relieve food shortages, is another activity at Fleetwings. Early this Spring, the company made garden tracts available to all employees who desired them. The response was tremendous. Now-a-days, after work, you'll find scores of Fleetwingers busy in their garden plots adjoining plant number two. They feel that growing what they eat is still another way to "keep 'em flying."

**TO GET YOUR COPY** of Fleetwings' monthly magazine, "The Arrow," merely write to us on your company stationery. In this magazine you'll find articles about production shortcuts, and other information of interest to men and women in the aircraft industry. Address your request to "The Arrow," at Fleetwings, Bristol, Pennsylvania.

*"KEEP 'EM FLYING!"*

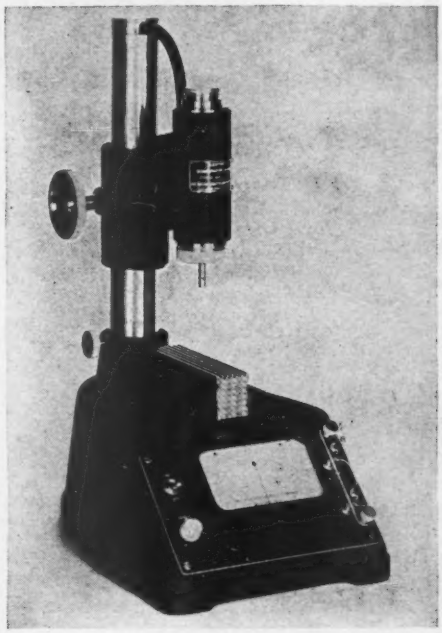
FLEETWINGS

*Division of Kaiser Cargo, Inc.*

BRISTOL • PENNSYLVANIA


**Comparator Gage.....75**

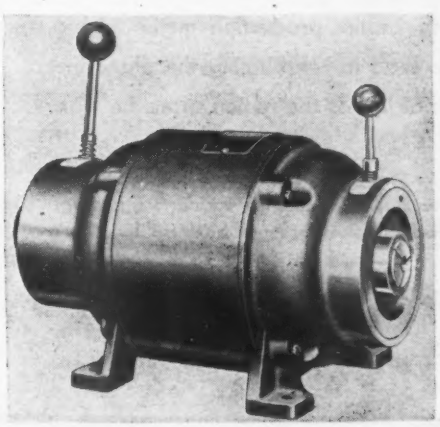
With ranges of ±0.0002, ±0.0004, ±0.002, and ±0.004, electric comparator gage manufactured by **Metron Instrument Co.**, Denver, has spindle-pressure range of 2 oz. to 2 lb. and



swiveling head which can be tilted according to indications on protractor. Firm states that with master part or gage block, gage can be set in 20 sec. through three adjustments: Rack and pinion elevator, vernier adjusting collar (four revolutions move spindle approximately 1/32 in.), and electrical zero adjustment.—AVIATION, *May,* '43.

**Polishing Lathe.....76**

Produced by **Crozier Machine Tool Co.**, Hawthorne, Calif., is new polishing lathe with clearance hole through entire machine permitting polishing of long pieces. Hardened, precision-ground, double-face cam mechanism permits positive opening and closing of collet. Adjustments can be made through hand grips, which increase or lessen collet tension, and work is loaded or unloaded while spindle rotates.





Switch and mechanical brake are provided for stationary loadings. Lathe, with dust-tight motor, is available in 14 models with varying electrical specifications, capacities, and collet and chuck arrangements.—AVIATION, *May,* '43.

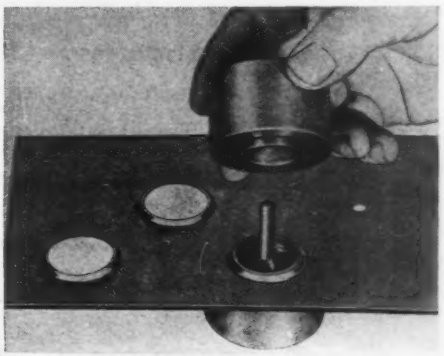
**New "Arctic" Tire.....77**

To facilitate landings and takeoffs on icy runways, **B. F. Goodrich Co.**, Akron, has developed this new tire with "parallel rows of steel coils imbedded in tread so edges take grip on ice and snow."

Steel coils, shown surrounding tire "carcass" during production, are bonded to rubber around circumference during vulcanization under new method.—AVIATION, *May,* '43.

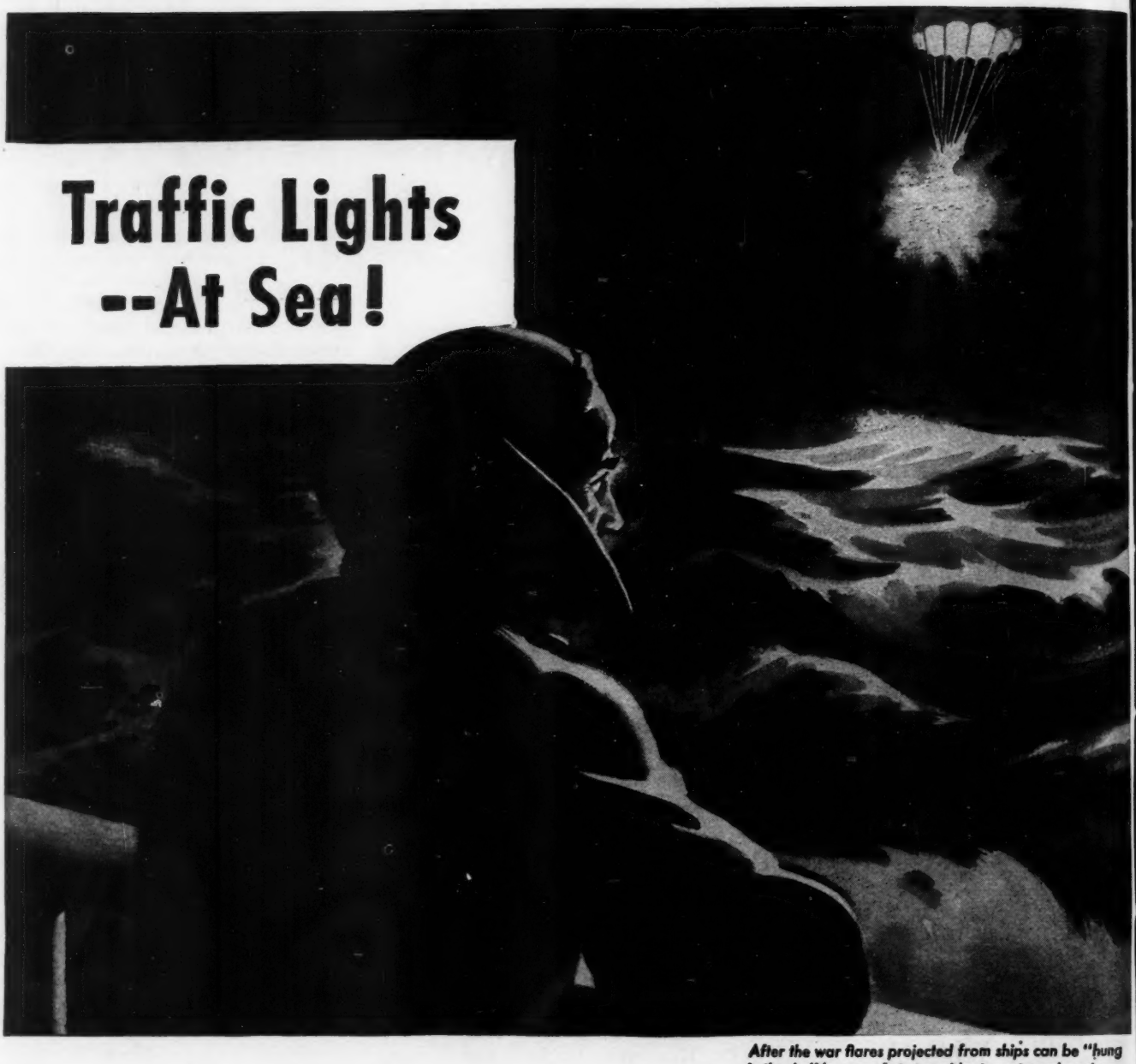
**Hole Puncher.....78**

Designed to cut and flange desired size hole in one operation, device illus-



trated is manufactured by aircraft tool division of **C-B Tools**, Lancaster, Pa., in sizes from 1 to 3½ in.—AVIATION, *May,* '43.

# Traffic Lights --At Sea!



*After the war flares projected from ships can be "hung in the sky" by parachute to guide storm-tossed mariners.*

THAT age-old invention, the parachute, has many modern commercial purposes beyond its indispensable place in aviation. Mail, medicine, industrial materials, food—yes, even eggs—all have in recent years been successfully delivered by parachute. Wartime developments have opened many new horizons for the parachute industry. By constantly redesigning and improving our 'chutes, by incorporating more safeguards, finding better materials, developing better production methods and lowering costs, Switlik has taken the lead in establishing the place the parachute will occupy in the industrial life of the nation after the war.

FIVE REEL SOUND FILM 16MM—*"Parachutes for Safety" may be had for a one-day showing by schools and colleges upon request. This unusual film describes the manufacture, packing, service, maintenance and use of parachutes. For data please write on letterhead to:*

SWITLIK PARACHUTE COMPANY TRENTON, NEW JERSEY

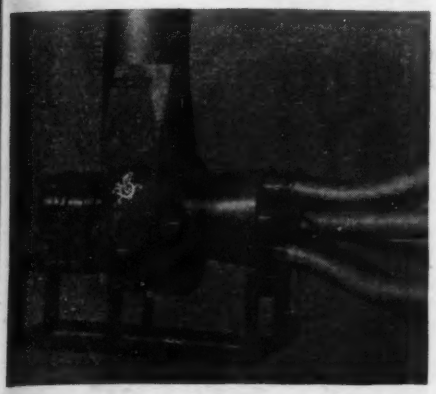
SWITLIK

*Safety Chutes*

FOR WAR AND PEACE

### Fume Exhauster ..... 79

Feature of new fume exhauster made by **Chelsea Fan & Blower Co.**, Irvington, N. J., is design in which gases, dust,



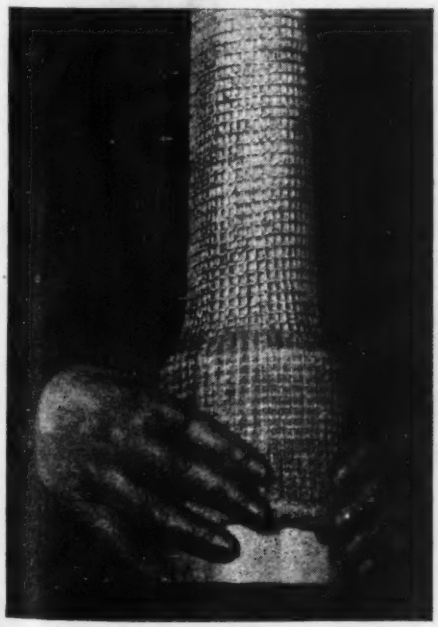
filings, etc., do not come in contact with 3-hp. blower motor. Centrifugal blower wheel is of ⅛-in. steel. Welded framework has carrying handles. Adapter is available for suction purposes.—AVIATION, *May*, '43.

### Solenoid Contactor ..... 80

Introduced by **Guardian Electric Mfg. Co.**, Chicago, is solenoid contactor for remote control of aircraft starters. Closes at 6 v. and is said not to chatter if voltage drops momentarily. Contacts, of single pole design, are rated at 200 amp.—AVIATION, *May*, '43.

### Finish Protector ..... 81

Shape-conforming boot has been developed by **Metal Textile Corp.**, Orange, N. J., for protecting super-finished and fragile parts in factories and during shipping. Outside sleeve of steel and cotton mesh and with lining of cotton mesh protects parts from contact with other hard surfaces, retains oil film,



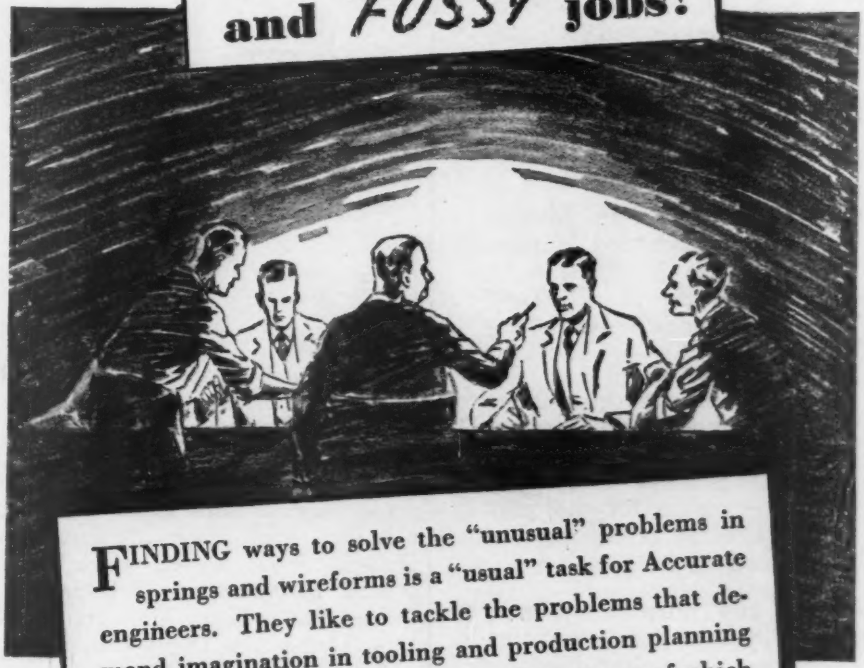
and excludes abrasive dust and foreign matter. Custom-made, boots are available in all diameters and lengths.—AVIATION, *May*, '43.

### Spring Tester.....82

**P. A. Sturtevant Co.**, Addison, Ill., is manufacturing new tool for testing compression springs up to 2½ in. diameter and 7 in. long. Announced features are operation by standard torque wrench which acts as lever and measure and sound device which indicates when spring has been compressed to desired

test point. Tester unit bolts to workbench and worker adjusts height of platform by revolving it on threaded column to match length at which spring is to be checked. Torque wrench is


We like the "TOUGH" and "FUSSY" jobs!



FINDING ways to solve the "unusual" problems in springs and wireforms is a "usual" task for Accurate engineers. They like to tackle the problems that demand imagination in tooling and production planning — and in testing and inspection devices, many of which are built especially for the job. Accurate engineers and production men have the experience and "know how" that offer short cuts to time, labor and material savings.

No requirements of a spring user are too exacting for Accurate Service — no problems too complex. Accurate customers know that—and if you have spring or wireform problems you will be pleased to discover it too. Send in your specifications or ask to see an Accurate engineer. You will like Accurate cooperation, quality and service.

*Send for the Accurate "Handbook on Springs"— it's convenient to use and informative — free, of course!*

Accurate Springs

ACCURATE SPRING MFG. CO., 3814 W. Lake Street, Chicago, Ill.

# LIBERTY AIRCRAFT MIRRORS

## *have gone to War*

•Liberty Aircraft Mirrors were developed to provide instant vision without eye strain or fatigue. They give the pilot a quick, accurate, image of what's "coming up."

Liberty Aircraft Mirrors are first surface mirrors and are permanent as their glass base. They are dependable and long lived.

These mirrors are built to meet the special requirements of each warplane. This insures clear rear view vision for the pilot regardless of the type of plane.

Liberty mirrors are now available for war purposes only, but after the war these new, battle tested, vision devices will serve the planes of peace.

# LIBERTY MIRROR WORKS

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**PENNSYLVANIA**

*Represented on the Pacific Coast by*
**W. P. FULLER & CO.**

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Fresno, California
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Boise, Idaho
Butte, Montana
Salt Lake City, Utah
Seattle, Washington
Spokane, Washington
Tacoma, Washington
Yakima, Washington
Portland, Oregon

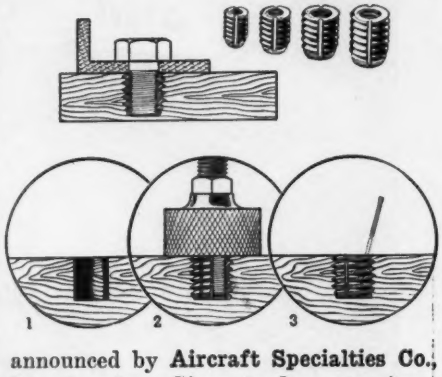
San Francisco California


## NEW PRODUCTS

pulled down to compress spring until it indicates point from which recoil pressure is to be measured. Sound device then clicks and reading is taken from scale of wrench.—AVIATION, *May,* '43.

### Anchor Inserts ..... 83

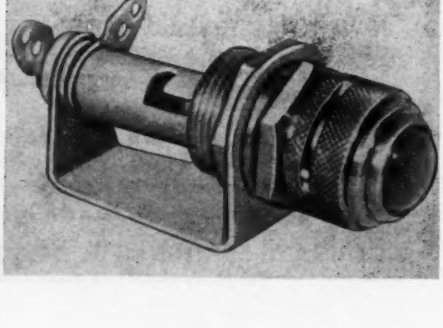
A new line of screw-in type blind anchor inserts for bolting metal to wood without going all way through wood is




announced by **Aircraft Specialties Co.**, Los Angeles. Given trade name Asco, new inserts are manufactured in four standard sizes and have withstood excessive pull-loads. Only three steps are necessary for installation: 1. Bore hole smaller than insert; 2. install with simple spiral wrench which fits into chuck of ordinary hand brace; and 3. drive two ordinary brads into slots in threaded outside, then lock insert to prevent its turning. When properly in place, insert is flush with surface of wood or plastic to which metal is to be joined.—AVIATION, *May,* '43.

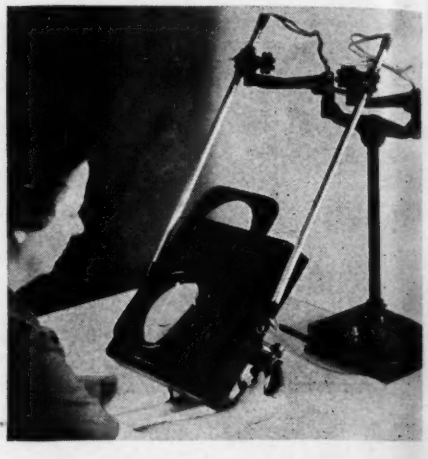
### Pilot Light ..... 84

Available with red, green, amber, blue, opal, or polarized lenses is pilot light of **Gothard Mfg. Co.**, Springfield, Ill. Rotation of shutters (90 deg.) reduces intensity of light from normal brilliance to "out."—AVIATION, *May,* '43.



### Fluorescent Inspection ..... 85

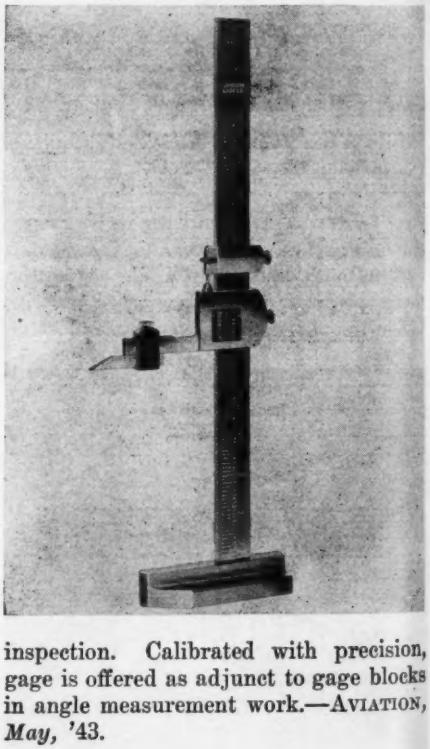
Combining indirect fluorescent illumination and magnifying lens of 5-in. dia.,



device manufactured by **Larrimore Sales Co.**, St. Louis, can be set at any angle for visual inspection of small parts.—AVIATION, *May,* '43.

### Height Gage..... 86

Vernier height gage in three standard sizes, 12, 18, and 24 in., English or metric, has been designed by **Jansson Gage Co.**, Detroit, for use in jig and fixture making and general layout and

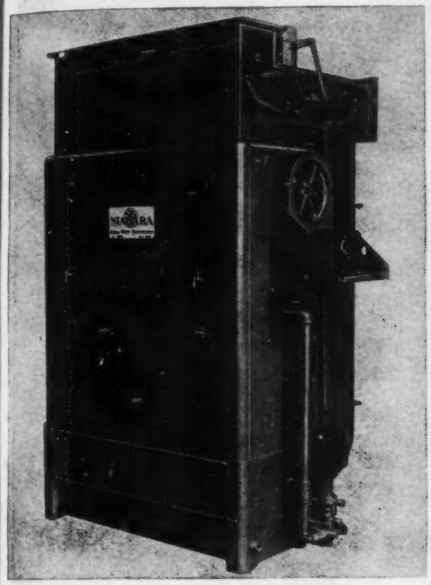


inspection. Calibrated with precision, gage is offered as adjunct to gage blocks in angle measurement work.—AVIATION, *May,* '43.

### Heat Exchanger ..... 87

New method of temperature control is featured in heat exchanger manufactured by **Niagara Blower Co.**, New York City. For cooling industrial liquids, unit's operation is based upon regulation of amount of outside air passing

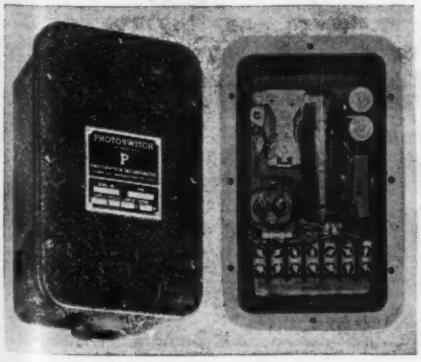
through evaporative cooling chamber rather than altering the flow of the liquid. Thermostat in contact with



liquid being cooled controls dampers on recirculating air duct. To prevent damage to apparatus in cold weather, minimum amount of air is admitted to keep water-spray temperature above freezing.—AVIATION, *May*, '43.

**Liquid Indicators . . . . . 88**

New series of electronic level controls has been designed for high and low level measuring of conductive and explosive liquids by **Photoswitch, Inc.**, Cambridge, Mass. Electrical apparatus, contained in vapor-proof, cast iron box, is mounted on rim of tank, and 1½-in.-dia. brass rod serves as contact medium to single-pole double-throw relay connections rated at 1,000 w. a.c. With conductive liquids, water or acids, in tanks of non-conductives, gasoline, oils,



# "Bombs Away!" *from Flying Fortresses with* SKF*-equipped engines*

● *Built by* WRIGHT AERONAUTICAL CORP.

You've read the headlines of bombs from Flying Fortresses that are constantly gnawing away the insides of Germany . . . of long distant raids that were unheard-of a few years ago. Back of these headlines are stories of how men and machines raced with time to produce bearings for the four 1200 h.p. Wright engines that made these exploits possible . . . of bearings that have a one-piece retainer permitting ease of disassembly and a thorough inspection of all parts. A plane that's driven by SKF-equipped engines is a symbol of security for Democracy. 5287

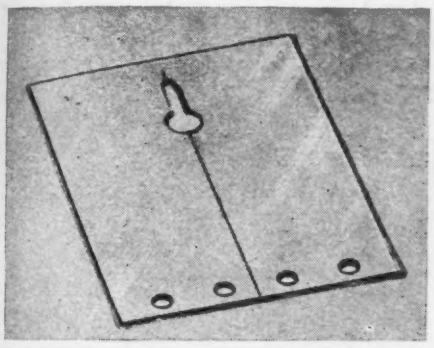
SKF INDUSTRIES, INC., PHILA., PA.

Tips
ON BEARING CARE
To make present equipment last longer
1. Use clean lubricant recommended by the manufacturer of this machine.
2. Avoid loads and speeds beyond those recommended by the manufacturer.
3. If necessary to remove bearings, keep them properly lubricated. Avoid the intrusion of water and dirt. Apply pressure on the inner race only. Don't hammer outer race.
SKF
BALL AND ROLLER BEARINGS

etc., relay does not operate until level of conductor (irrespective of level of non-conductor) reaches probe tip.—AVIATION, *May*, '43.

### Hairline Indicator .....89

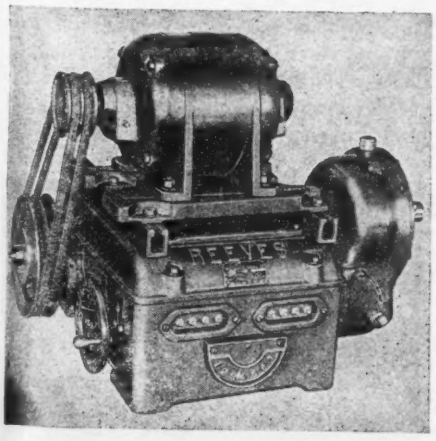
Manufactured by **Printloid, Inc.**, New York City, according to purchaser's specifications, indicator with index



line finer than human hair is plastic sheet 40/1,000 in. thick mounted in working position with screws. Indicator can be supplied in any size or thickness of line from 1/1000 in.—AVIATION, *May*, '43.

### Speed Controller .....90

Employing helical reduction gears, Reeves variable speed transmission with built-in speed reducer is available in horizontal or vertical enclosed designs with fittings for any standard motor




from 1 through 7½ hp. Ratios produced are 2:1 through 12:1, reduction gears giving ratios up to 6.9:1. Speed changes are controlled by a hand wheel with attachment available for mechanical or hydraulic regulation. Parts are




WHERE AIRCRAFT RUN ON "ROADS"

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... equipped with

GENERAL JUMBO Jrs.

Today's paving jobs, whether on airport runways or on the highway, must keep pace with these strenuous times . . . must be completed *fast*, with *maximum efficiency*. That's why you'll find HI-WAY Spreaders, manufactured by the Highway Equipment Co., Cedar Rapids, Ia., on important paving jobs. HI-WAY Spreaders equipped with GENERAL Jumbo Jrs. —*industrial pneumatic tire favorite!*

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***Available in new air corps specification sizes. Also for war orders and for certain essential industrial uses.***

General Jumbo Jrs. roll easily anywhere . . . cushion and protect load, truck, floor or dock. Traction is exceptional—filings, chips and clippings aren't picked up. Exclusive and patented, Jumbo Jrs' design makes possible service unequalled by any other pneumatic industrial tire!

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Here are a few of the charts, tables and other information in your Data Book:

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- Fits and tolerances
- Drill and ream notes
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- Insulated wire sizes
- Surface cutting speeds for automatic screw machines
- Welding torch tip and drill sizes
- Rod size current volt table
- Rod motion pattern—arc welding
- Set back chart for bending
- Directory of protective coatings
- Standard colors for fluid line identification
- Dictionary of aircraft shop terms
- Weight conversion charts
- Steel type and numbering chart
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Here is the book aircraft workers and students have waited for — a new "tool" that helps speed work in every department. Whatever your aircraft job, the DATA BOOK is a complete reference library, with technical tables and formulae for engineers . . . charts, tables and other information to aid every man and woman in the industry . . . plus a Dictionary of Aircraft Shop Terms.

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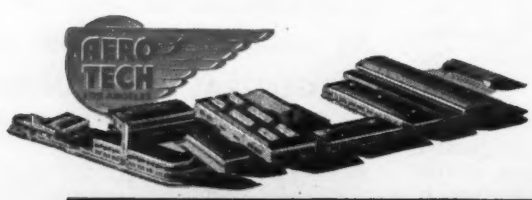
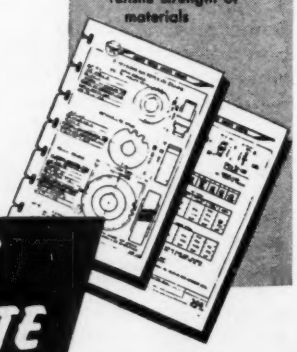
Ask at your plant library for Aero Tech's AIRCRAFT DATA BOOK. If you want a copy of your own, ask for it at your factory store or mail the coupon below.



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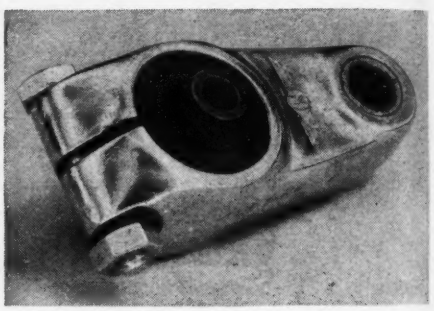
A-1-A


## NEW PRODUCTS

lubricated by splash system with three plugs for filling, changing, and determining oil level. Maker: **Reeves Pulley Co.**, Columbus, Ind.—AVIATION, *May*, '43.

### Connector Link . . . . . 91

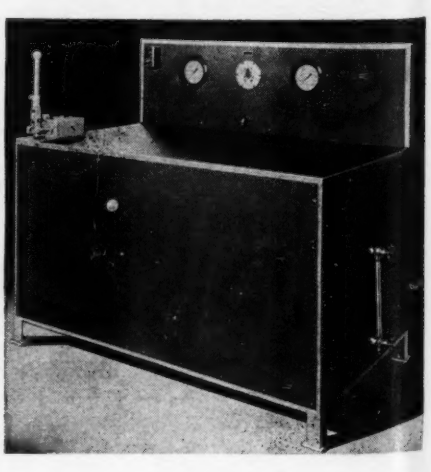
Kinney engine cowl ring connector link, made by **Kinney Engineering Co.**, Los Angeles, is reported to embody these



improvements: Rubber bushing to absorb engine and flight vibration and rocker arm to take up normal engine heat expansion. Material is heat-treated, X-ray-tested aluminum alloy.—AVIATION, *May*, '43.

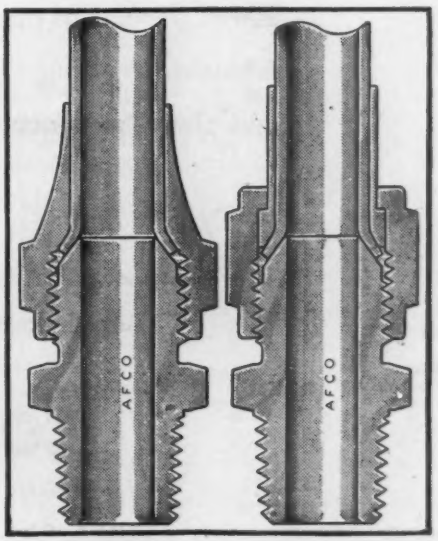
### Test Bench . . . . . 92

Designed and built by **R. Voight & Son**, Buffalo, this hydraulic test bench has built-in sealed oil tank, oil filter, and oversized piping. Model illustrated is 5 ft. 6 in. long, 4 ft. wide, 4 ft. 9 in. high, and weighs about 1,500 lb. Perforated steel working surface is 3x5 ft., large enough to accommodate parts of fighter aircraft. Unit circulates 30 gpm. under pressure.—AVIATION, *May*, '43.

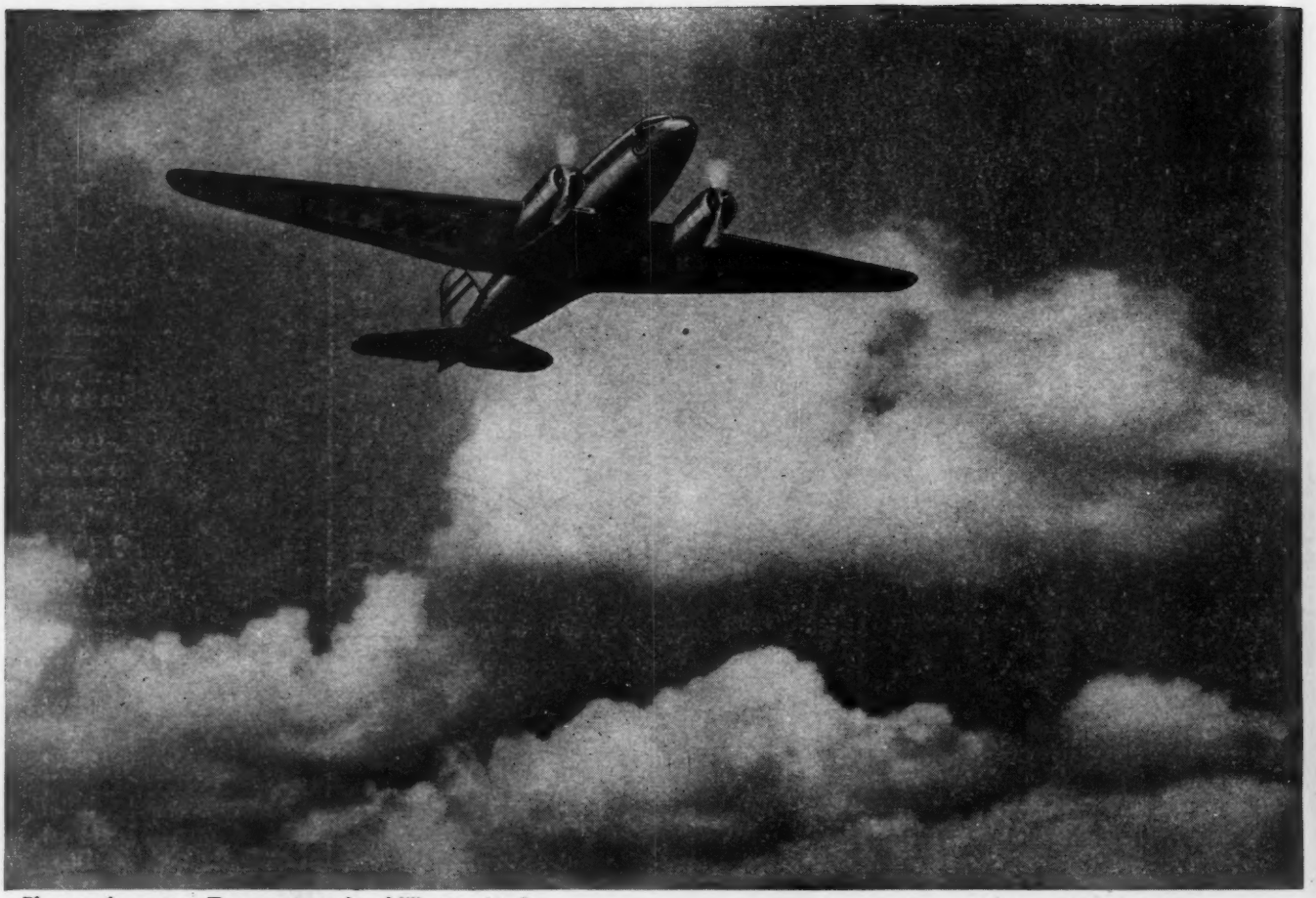


## that they shall fly today—*AND TOMORROW*

Our nation's armed forces have honored us with the Army-Navy "E" flag, for excellence in war production. We are proud of that flag, proud of our skilled craftsmen who made possible the winning of the award. ★ But, none of us in the aviation field can rest on our laurels. That is why we pledge not only to continue to produce fine fittings to help make our American Air Force the best in the skies, but also to be ready to aid in peaceful days to come when America's wings will be called upon to carry American products to all corners of the earth. ★ The Aircraft Fitting Company, 1400 East 30th St., Cleveland, Ohio... manufacturers of the new "AN" standard tube couplings and pipe fittings.




# afco fittings



*Photograph, courtesy Transcontinental and Western Air, Inc.*

# THERE MUST BE DEPENDABLE COMMUNICATIONS

The reliability of Wilcox communications and other radio equipment has made them invaluable servants of leading commercial airlines.

Now, the entire output of Wilcox factories is going to wartime uses, and the experience gained during peacetime is standing in good stead for military operations.

Thus, Wilcox is keeping pace with the miracles of flight...and, after Victory, new Wilcox developments will be available for the better-to-live-in, sane, sensible world ahead.

Communication Receivers
Aircraft Radio

Airline Radio Equipment
Transmitting Equipment

## WILCOX ELECTRIC COMPANY

*Quality Manufacturing of Radio Equipment*

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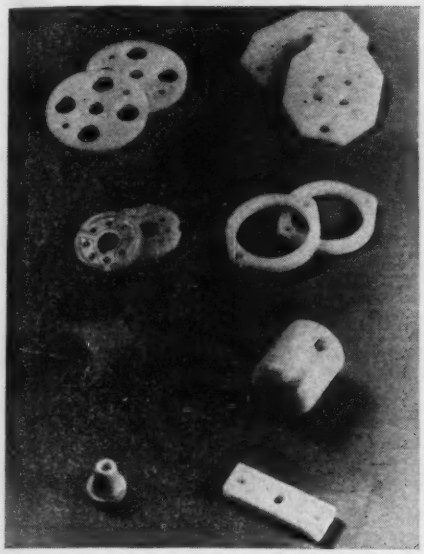
## NEW PRODUCTS

### Glass Insulators ..... 93

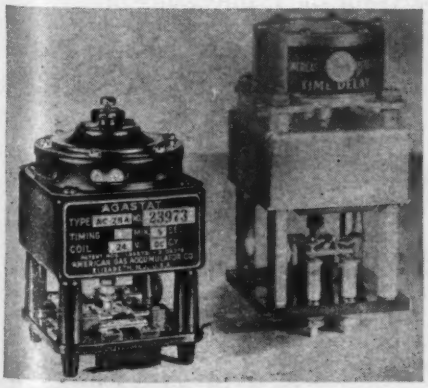
Process of cold molding and subsequent fusing has enabled **Corning Glass Works**, Corning, N. Y. to produce from



standard glass compositions threaded, grooved, and holed insulators for crystal holders, mounting blocks, radio coil forms, etc. Announced advantages are minimum frequency drift, negligible water absorption, and low loss factor.—AVIATION, *May*, '43.

### Light Relay ..... 94

Retaining same diaphragm timing principle, redesigned "Agastat" electropneumatic relay of **American Gas Accumulator Co.**, Elizabeth, N. J., is but 1 lb. 6 oz. in weight and 4 instead of 5 in. high. Used for making and breaking electrical circuits at pre-determined intervals, relay has screw adjustment for regulating timing from fraction of second to several minutes.—AVIATION, *May*, '43.





# *An Important Message to*
# Technical Men

**The war has carried the manufacturing age to a new peak! Production demands have created technical problems the like of which the world has never seen before! The services of engineers are at a premium. Especially the services of one particular class—executive engineers—*engineers with business training;* engineers who can "run the show."**

**In these critical times, the nation needs engineers of executive ability *now, today*—not five, or ten years from now! The shortage of such men is acute—even more acute than that of skilled production workers. And company heads, aware of this situation, are offering high rewards to engineers who have the necessary training in industrial management.**

## Golden Opportunity for Engineers

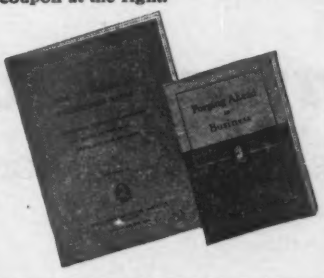
**In this new era, the engineer with vision and foresight has a golden opportunity. He will realize that out of today's tremendous production battles will emerge technical men who not only will play a major role in winning the war, but who also will be firmly entrenched in key executive positions when peace comes.**

**However, before the engineer can take over executive responsibilities, he must acquire knowledge of the other divisions of business—of marketing, accounting and finance. He has of necessity a vast amount of technical training and experience. But in order to grasp the opportunities that present themselves today—to assume leadership on the production front—he must *also* have an understanding of practical business principles and methods.**

**The Alexander Hamilton Institute's intensive executive training can give you this essential business training to supplement your technical skill.**

## FREE help for engineers

**Ever since the war began, there has been an unusually heavy demand on the part of our technically-trained subscribers for the Institute's special guide on "How to Prepare an Engineering Report". Extra copies of this practical, helpful 72-page Guide are now available and, for a limited time only, will be sent free to all technical men who use the coupon at the right.**



**134,000 men on the operating side of business have enrolled for this training. More than 37,500 are technical men—engineers, chemists, metallurgists—many of whom are today heads of our huge war industries.**

**This training appeals to engineers because it gives them access to the thinking and experience of the country's great business minds. It is especially valuable to such men because it is basic, not specialized—broad in scope, providing a thorough groundwork in the fundamentals underlying *all* business. It covers the principles that every top executive must understand. It applies to all types of industrial organizations, because all types of organizations are based on these same fundamentals.**

## Business and Industrial Leaders Contribute

**The Institute's training plan has the endorsement of leading industrialists and business men. And it is only because these high-ranking executives recognize its value and give their cooperation that such a plan is possible. Among those who contribute to the Course are such men as Frederick W. Pickard, Vice President and Director, E. I. DuPont de Nemours & Co.; Thomas J. Watson, President, International Business Machines Corp.; James D. Mooney, President, General Motors Overseas Corp.; Clifton Slusser, Vice President, Goodyear Tire and Rubber Co. and Colby M. Chester, Chairman of the Board, General Foods Corp.**

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**The facts about the Institute's plan and what it can do for you are printed in the 64-page book, "Forging Ahead in Business". This book in its own right is well worth your reading. It might almost be called a handbook of business training. It is a book you will be glad to have in your library, and it will be sent to you without cost. Simply fill in and mail the attached coupon *today*.**

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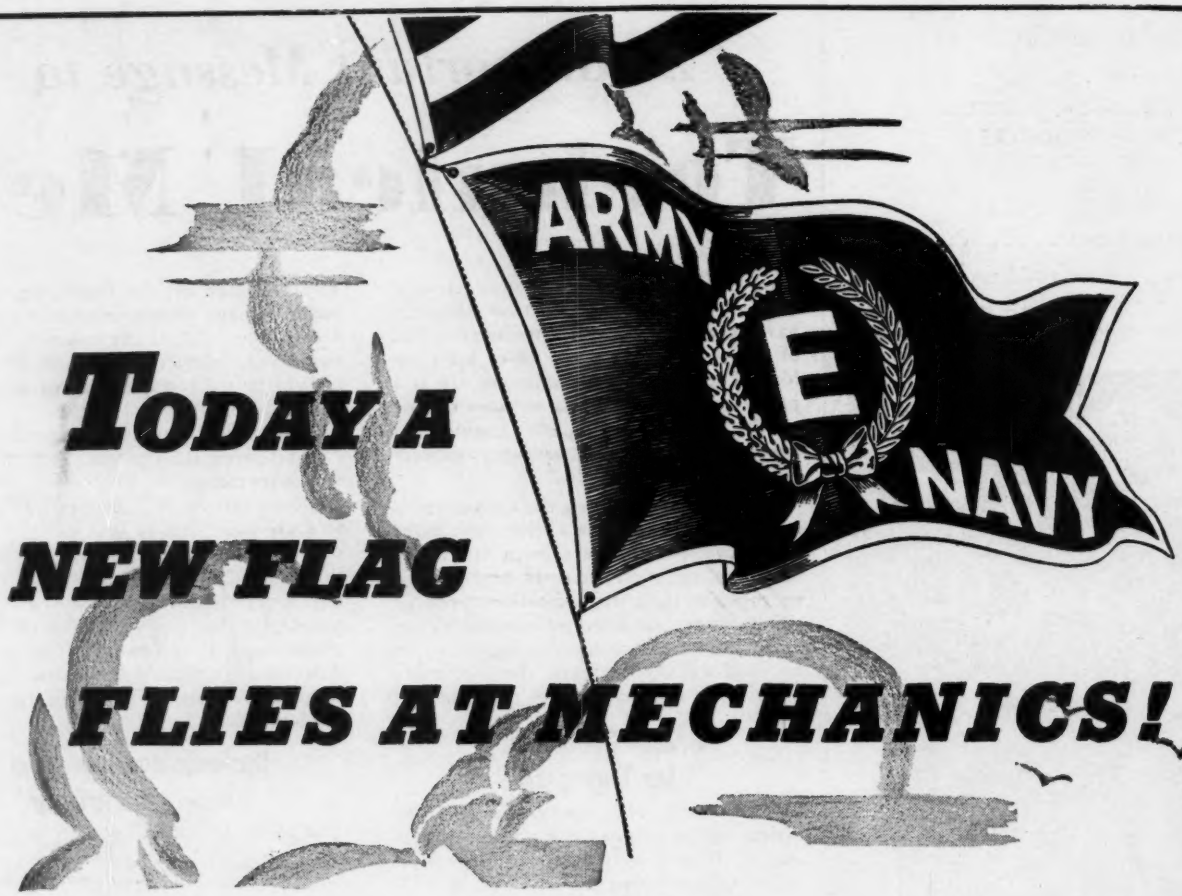



# TODAY A NEW FLAG FLIES AT MECHANICS!

TODAY—like three other famous Borg-Warner divisions, Pesco, Long Manufacturing and The Spring Division—Mechanics has received an Army-Navy "E" flag "for outstanding achievement in producing war equipment."

This equipment includes matériel that is seeing action on every fighting front. Magazines for aircraft cannon, shell fuzes, universal joints for trucks, tanks, tank destroyers, armored vehicles, planes, surface and undersea craft.

Just two weeks after our first deliveries of the magazines for aircraft cannon, our quota was jumped 1000%. We accepted the challenge. With strict adherence to the highest quality standards, we stepped up our production rate and met the almost impossible delivery dates.

We are proud of our new "E" flag—and grateful to the Army and Navy for this distinction they have conferred.

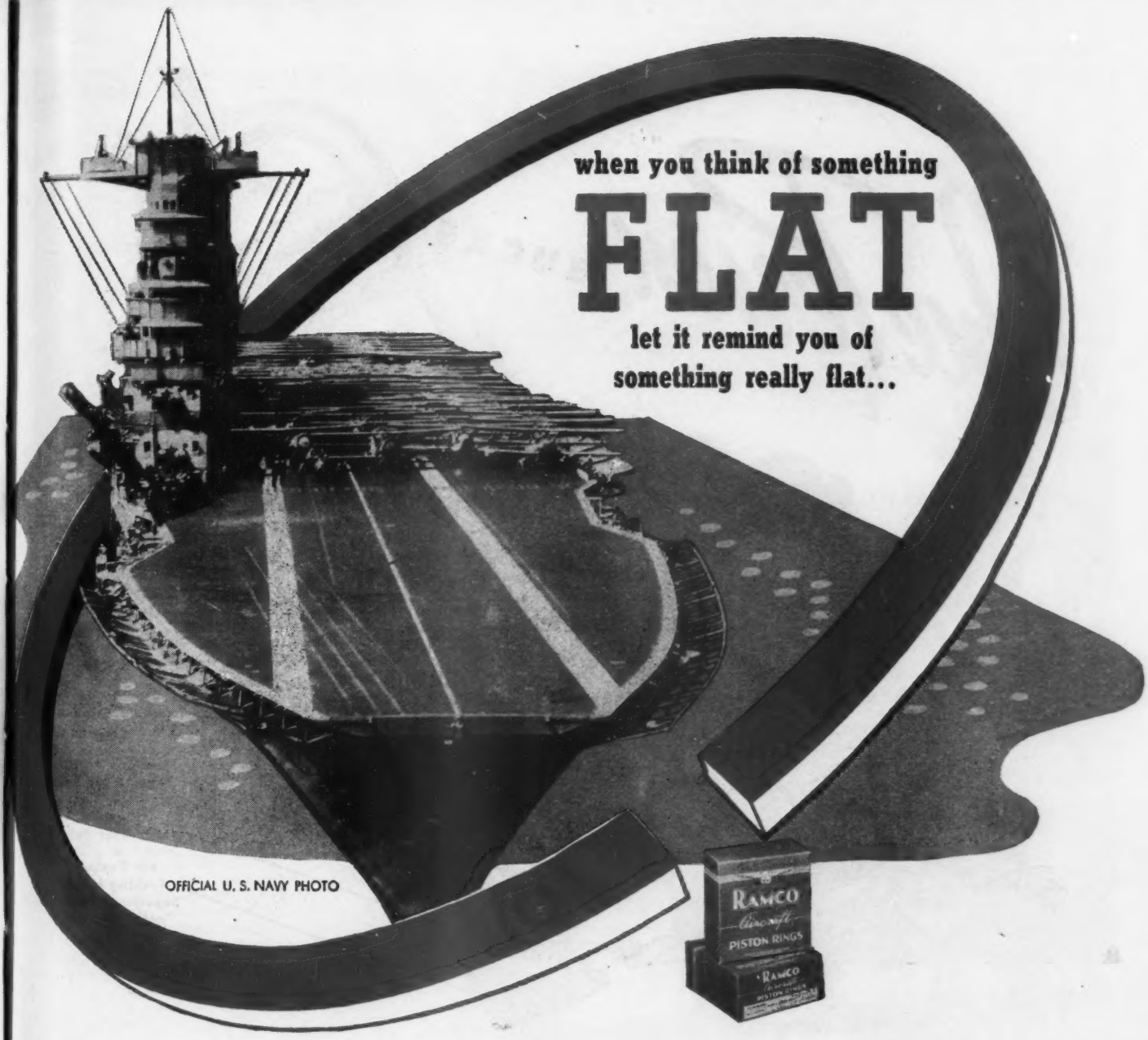
But we must confess that this award came as no real surprise to those who have known the fine performance of Mechanics production through years of peace.

Today, while doing this vital war job, Mechanics continues to anticipate important home front needs. We are turning out our full share of parts for industry and essential transportation. And for the farmer, on whom depends so much of our success at home and on the battle field, we are supplying parts for the maintenance of tractors, trucks and implements.

## MECHANICS UNIVERSAL JOINT DIVISION

*BORG-WARNER CORPORATION . . . ROCKFORD, ILLINOIS*

*"In transportation . . . industry . . . aviation . . . and on the farm"*




# RAMCO MICRO LAP

## AIRCRAFT PISTON RINGS

Tolerances to the millionths of an inch are symbolic of the precision required of piston rings employed in military aviation.

Ramco Aircraft Rings now being supplied to help meet military requirements are being manufactured in a new Ramco plant. In tooling up this plant for the manufacture of aircraft rings, Ramco has drawn upon its twenty-five years of engineering experience in piston rings and utilized the latest developments in machines and methods.

Among the advanced methods of manufacture employed by Ramco is Ramco Micro-Lap...an advancement in lapping which insures flatness to extreme tolerances. Because of this and other developments, Ramco Aircraft Rings are produced to extreme tolerances with maximum efficiency and speed.

For a fuller description of these facilities, write for a reprint of a recently published magazine article on the new Ramco Aircraft Piston Ring Plant. The facilities of this plant and that of our plant producing automotive, tank, and industrial piston rings are available wherever they can be utilized to further the war effort.

Address all correspondence to General Offices, Ramsey Accessories Mfg. Corp., 3706 Forest Park Blvd., St. Louis, Mo.

FOR VICTORY BUY WAR BONDS

One Person BUCKS AND RIVETS
Attachment for Counter Balance
Brace Eliminates Excessive Deflection
Quick Adjusting Turnbuckle
Attachment for Counter Balance
Gun can be rotated to any handle position
Standard Parker Taper Rivet Set
Standard Squeezer Set
Air Cushion Bucking Head. Superior to manually held bar

# AERO TOOL PORTABLE AUTOMATIC BUCKER

SPECIFICATIONS

**APPLICATION**—To buck rivets automatically.

**FEATURES**—Releases one operator. Air cushioned Bucking Head gives operation superior to manually held bar. Perfect alignment of Bucking Bar and Rivet Set is always assured. When Rivet Set contacts rivet, Bucker is always against shank. Adaptable to work where long throat is required.

**CONSTRUCTION AND MATERIALS**—Gun clamp and Bucking Head of cast steel. Yoke of heavy tubular steel with brace incorporated. Aero Tool Portable Automatic Bucker operates with pistol type gun.

**SIZES**—Aero Tool Standard Portable Automatic Bucker weighs 14 lbs. and has 22" throat. Larger sizes manufactured to specifications at additional charge. Standard Rivet Sets and Standard Squeezer Sets are used in all operations. Note: A treadle operated bench model is also available.

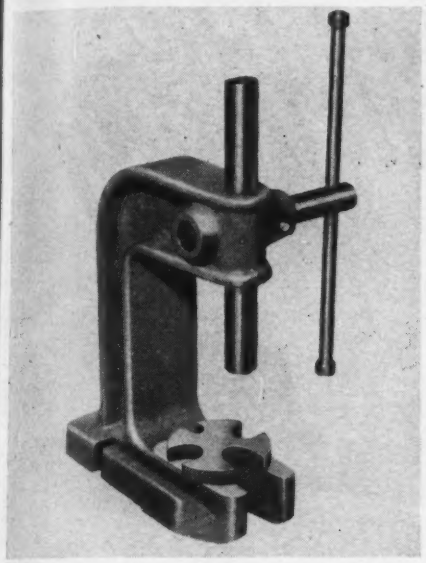
**ORDERING INSTRUCTIONS**—When ordering, ask for Aero Tool Portable Automatic Bucker and specify rivet size and whether desired with or without gun.

**AERO TOOL CO.**
CUPFORGED AVIATION TOOLS

233 WEST OLIVE AVENUE, BURBANK, CALIFORNIA • CABLE ADDRESS AERO

### Hand Arbor Press ..... 95

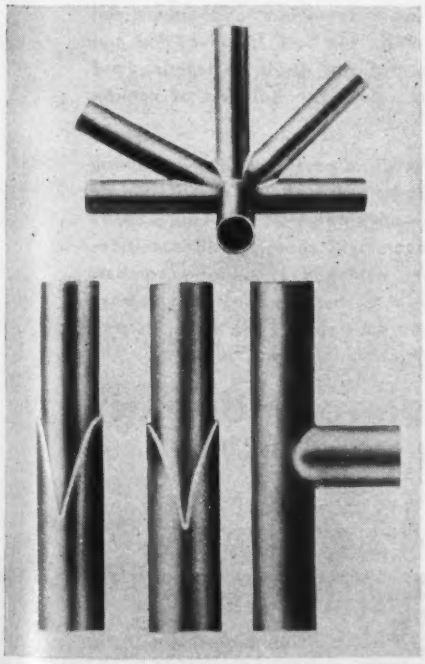
Made both in bench and wall models by **Lempco Products**, Bedford, Ohio, is two and three-ton capacity arbor press



having heavy wrought-steel pressing block notched with $1\frac{1}{4}$, $1\frac{5}{8}$, and $1\frac{7}{8}$-in. openings. Machine, of I-beam design with machine bearings, will take work up to 14-in. diameter and is designed for assembling, bending, and straightening operations requiring up to three tons pressure. Illustrated is bench type. —AVIATION, *May*, '43.

### Low-Temperature Welding....96

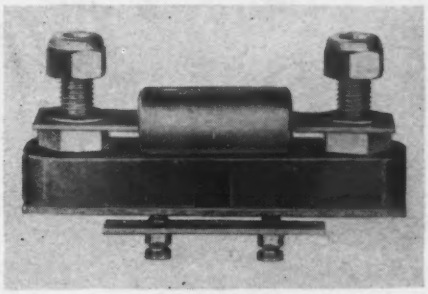
Illustrated are joints made in aircraft chrome-molybdenum steel tubing with low-temperature alloy welding rod No.



16 produced by **Eutectic Welding Alloys Co.**, New York City. Reported are advantages of reduced heat and free flowing properties.—AVIATION, *May*, '43.

### Fault Limiter ..... 97

Unaffected by amount of current passing through a circuit, this electrical fault limiter, offered by **Burndy Engineering**



**Co.**, New York City, limits duration of heavy overloads—four or five times rated capacity—in plane circuits. Normally installed in series with reverse current relay, it is designed to clear circuit if relay fails to operate. Where

THE Herman Nelson Portable Self-Powered Heaters were successfully used last winter at Army and Navy Bases everywhere.

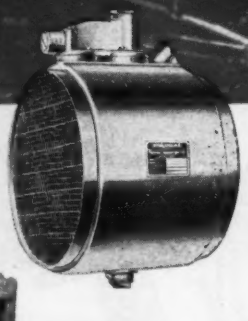
Many inquiries were received from aircraft manufacturers, airline and airport operating personnel who had seen this equipment at work. Because of last year's commitment to the Armed Forces for our entire production of this Portable Self-Powered Heater, we were unable to supply them to anyone else.

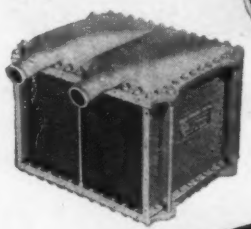
Now, however, we are in a position to schedule orders for delivery before next winter. If you want to avoid many of the cold weather difficulties you might encounter next winter — NOW is the time to act. Write for complete information about our portable, light-weight, sturdy, self-powered ground heater. Capacity 250,000 BTU per hour.

THE HERMAN NELSON CORPORATION
*Manufacturers of*
*Quality Heating, Ventilating and Air Conditioning Products*
MOLINE, ILLINOIS

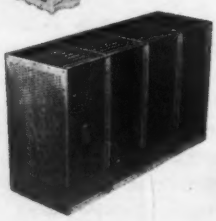
*F. M. Young built engine cooling radiators for the Glenn L. Martin "round the Great Lakes endurance flight" back in 1913.*

OIL TEMPERATURE REGULATORS



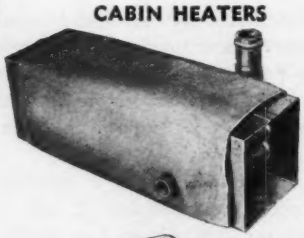


RADIATORS FOR LIQUID COOLED ENGINES



SUPERCHARGER INTERCOOLERS

CABIN HEATERS



**DISTRIBUTORS:**
Pacific Coast and Southwest:
**PACIFIC AIRMOTIVE**
Burbank, California
Southwest and Central West:
**AIRCRAFT STEEL & SUPPLY CO.**
Wichita, Kansas

## AERONAUTICAL HEAT TRANSFER EQUIPMENT

**Men of Young Radiator Company have pioneered in the building of better heat transfer equipment. YOUNG Oil Coolers, Oil Temperature Regulators, Radiators, Supercharger Intercoolers and specialized heating and cooling units for both liquid-cooled and "air-cooled" engines, are the result of training and experience that started with the building of cooling equipment 30 years ago.**

**YOUNG Heat Transfer Units now in service in training planes and Allied combat planes over many fighting fronts incorporate the advantages of this long experience. YOUNG engineers will comply with specification changes to meet demands of military combat; equipment will be built to the requirements you have to meet. We welcome your special problems, as well as "straight line production" of standard units.**

**YOUNG RADIATOR COMPANY**
**DEPT. 293-E RACINE, WIS., U.S.A.**

*Buy Bonds; Produce More; Salvage Scrap; Win the War*

PRODUCT OF Young ENGINEERING AND MANUFACTURING SERVICE SPECIALIZING IN HEAT TRANSFER PRODUCTS

OIL COOLERS • GAS, GASOLINE, DIESEL ENGINE COOLING RADIATORS • INTERCOOLERS • HEAT EXCHANGERS ENGINE JACKET WATER COOLERS

Young

UNIT HEATERS • CONVECTORS • CONDENSERS • EVAPORATORS • AIR CONDITIONING UNITS • HEATING COILS • COOLING COILS

HEAT TRANSFER PRODUCTS

circuits are fed by more than one current source on multi-engined craft, fault limiter can be placed to cut out both power supplies to prevent perpetuation of short circuit.—AVIATION, *May*, '43.

**Lifting Truck ..... 98**

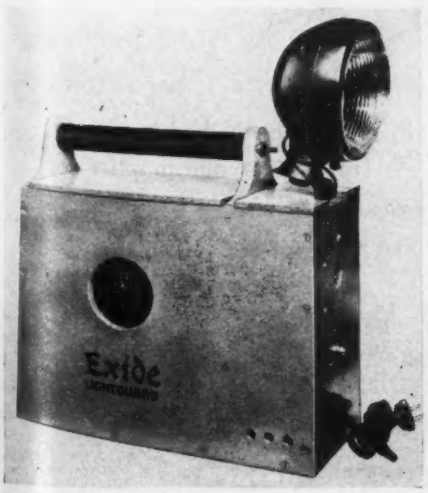
Specifications of newly-offered center control, telescopic lift tilting fork truck are: Load 2,000 lb.; length, including

30-in. fork, 98 in.; single fork height lift 71½ in., with telescopic lift 129 in.; four speeds forward and reverse. Known as Model KM30-2, unit is offered by **Yale & Towne Mfg. Co.'s** Philadelphia division.—AVIATION, *May*, '43.

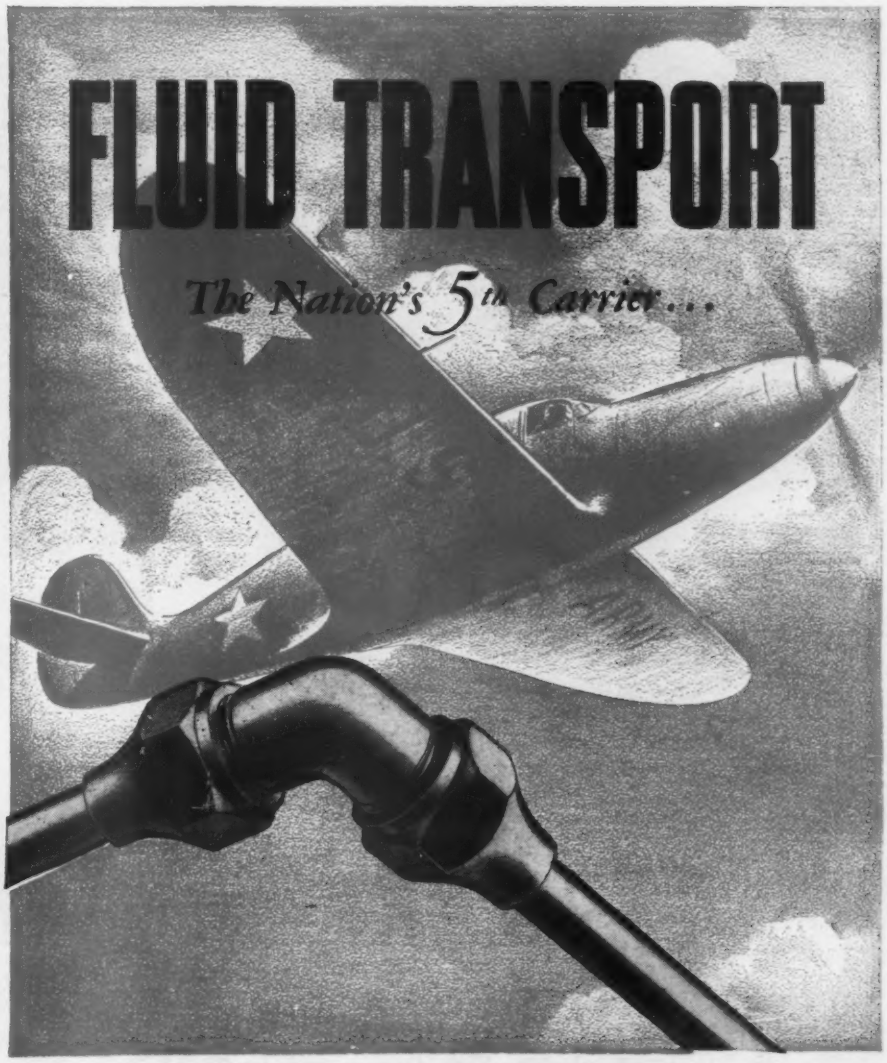
**Emergency Light ..... 99**

Designed to operate instantly without switches at moment of power failure, new emergency light produced by **Electric Storage Battery Co.**, Philadelphia, consists of lamp with bulb similar

(*Turn to page* 312)

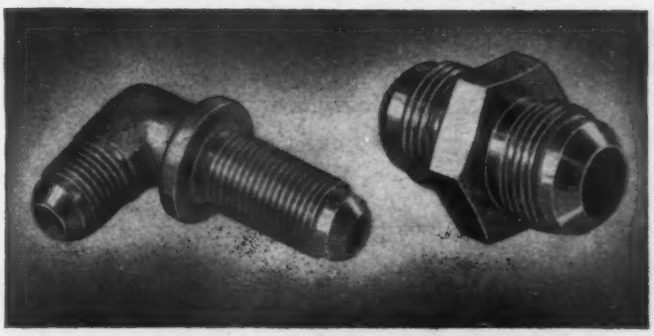







**"AN" STANDARD FITTINGS FOR AIRCRAFT TUBING.**

Grinnell production of these fittings for gasoline, oil, air and hydraulic fluids is being constantly increased to help you build air superiority for our forces everywhere. Grinnell Company, Inc., Executive Offices, Providence, Rhode Island.



GRINNELL

WHENEVER **PIPING** IS INVOLVED

**Plants, Branch Warehouses, and Sales Offices in Principal Cities**

# Low Voltage D.C. Motors NEVER SAY DIE if they have built-in KLIXON PROTECTORS

All low voltage D.C. motors going into planes and tanks should have built-in Klixon Overheat Protectors. It's protection that our fighting men need. For example, what would happen if a landing gear motor burned out? Or what good is a gun if the gun turret motor burns out in a jam?

Motors with built-in Klixon protectors *can't burn out*. If something jams and the motor is overloaded, the Klixon Protector cuts the motor off the line the instant it becomes too hot. Then with the automatic reset types when the motor cools to a safe operating temperature, it goes "on" again automatically. It keeps trying on an "on" and "off" basis until the jam or trouble is corrected. It *never says die*.

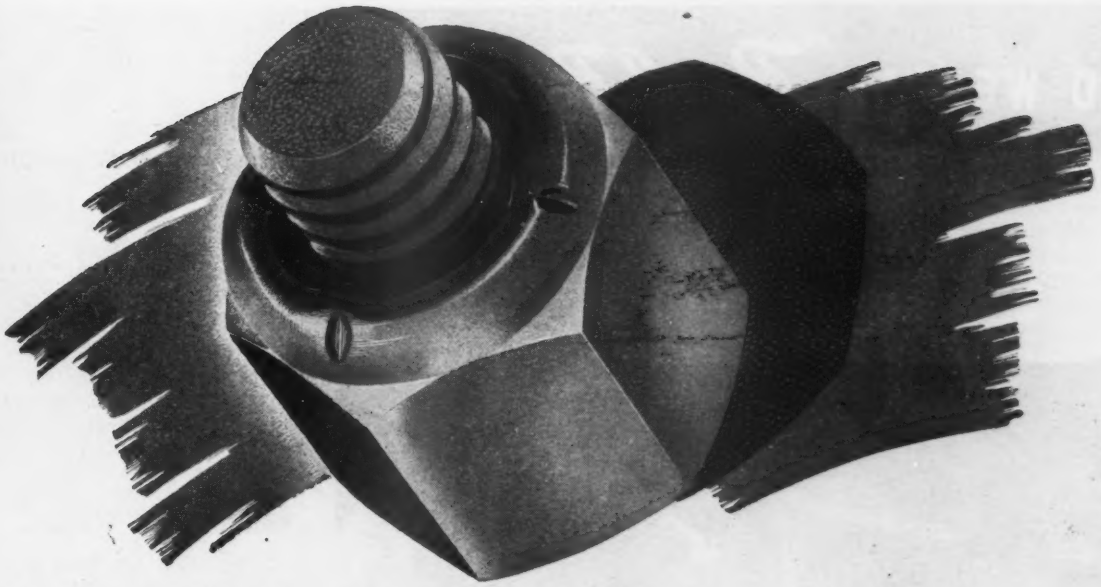


Klixon Built-in Protectors can be had with any D.C. motor up to 30 volts. Ask your supplier for this foolproof-proven protection. Automatic and manual reset types available.

KLIXON

TRADE MARK REG. U.S. PAT. OFF.

**SPENCER THERMOSTAT COMPANY · ATTLEBORO, MASSACHUSETTS**



# ANCHORED *Forever*

## ...OR RELEASED IN AN INSTANT!

The efficient Greer *Self-Locking* Nut solves many a tough engineering problem. So simple in principle . . . so easy to apply . . . *YET* so *powerful* in it's unshakable locking grip! It's 100% secure, clamped and *set* against every conceivable vibration! *Best of all*, an ordinary wrench unclamps it again in an instant!

### VIBRATION TESTED FOR THOUSANDS OF HOURS

Probably the toughest test of all for GREER *Self-Locking* Stop Nuts is on pneumatic drills. Here they pass thousands of grueling hours of violent vibration with flying colors . . . NOT ONE has shaken loose to our knowledge.

### GREER STOP NUT MEETS AIRPLANE REQUIREMENTS

Where small but strong fastenings must be applied (and later removed) . . . are subjected to vibration and must stay ABSOLUTELY TIGHT . . . GREER *Self-Locking* Nuts have proved to be ideally suited.

**GREER**

*Self-Locking Nuts*

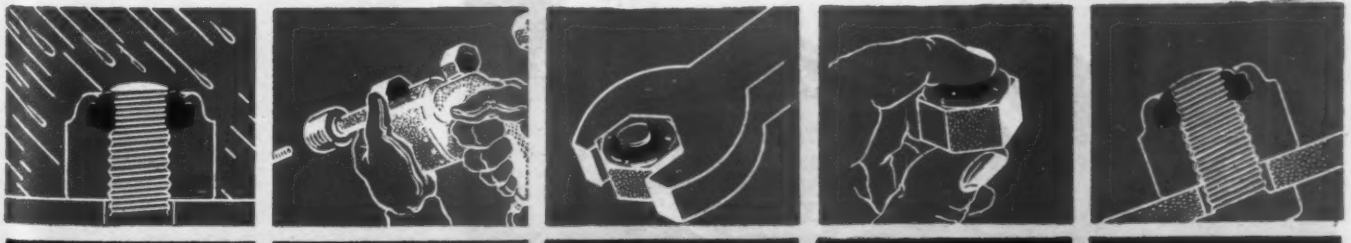
### GREERCOID COLLAR HAS DUAL ROLE!

Flexible but extremely tough . . . the Greercoid Built-In Lock has just the right resiliency to "soak up" any "shortwave oscillation" attempting to start between nut and bolt. It also serves as a powerful set-clamp and braking surface. Compression plus flexibility give it an unshakable grip and generate much added holding power in the lower threads also. Greer Self-Locking Nuts are identified by the Black Center.

### ALL SIZES FOR STANDARD OR SPECIAL THREADS

Write today, outlining your requirements. Fredric Greer Company, 2620 W. Flournoy Street, Chicago, Ill.

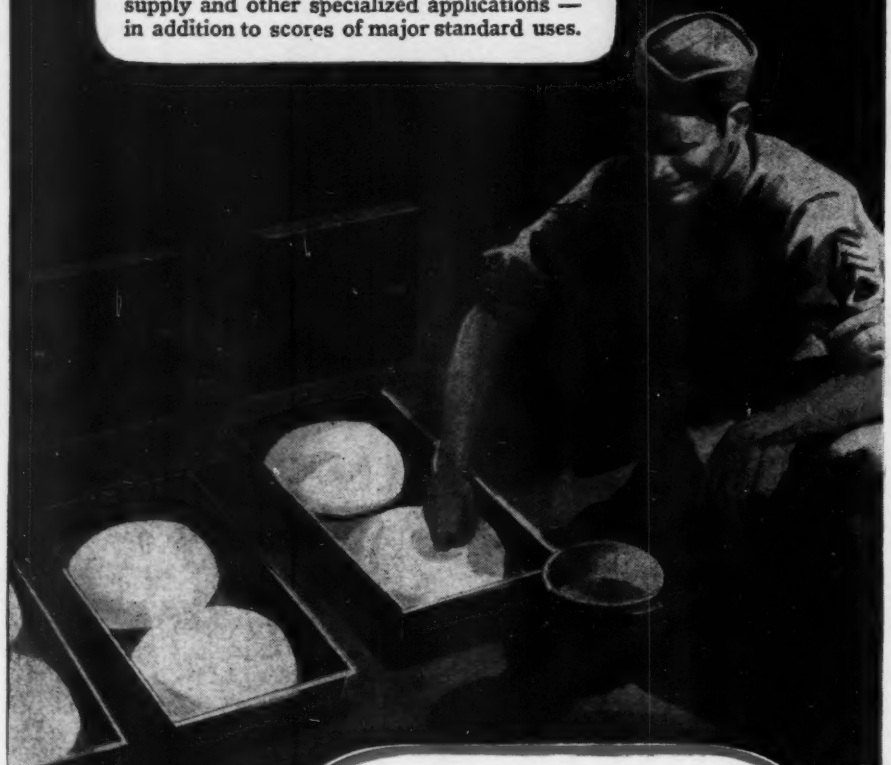
### GREER ELASTIC STOP NUTS FOR APPLICATION IN ALL INDUSTRIES



| SEALED | FASTER ON | FASTER OFF | RE-USABLE | NO PLAY |
|---|---|---|---|---|
| Protects working threads. | Tighten, and it's on to stay! | Ordinary wrench does it! | Use them again and again! | Keeps threads tight. |

AND WE HAD "Real Bread"

"Our boys," in distant lands, get *real bread* — made the American way in "portable" kitchens. Just another way Briggs & Stratton gasoline motors are serving — furnishing power for bread mixers, refrigerators, water supply and other specialized applications — in addition to scores of major standard uses.



We're in full production on Briggs & Stratton 4-cycle, air-cooled gasoline motors — for the war program and approved "essential" civilian uses — but there are not enough "new" motors available to supply the demand. As a special service, we are trying to place "used" Briggs & Stratton motors that may not now be in active service, in the hands of those who need them so badly.

*If you have, or know of any Briggs & Stratton motors not now in regular use—please write us, stating model numbers and general condition. It makes no difference how old they are. We will assist in making contacts between owners and prospective purchasers.*

BRIGGS & STRATTON CORP.
MILWAUKEE, WIS., U. S. A.

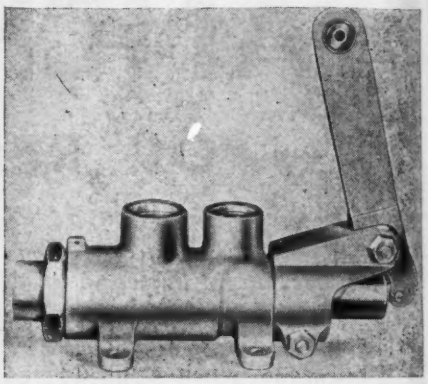
4 CYCLE
BRIGGS & STRATTON
GASOLINE MOTORS

FOR VICTORY
Invest in
WAR BONDS

to that in automobile headlight, three-cell storage battery in glass jar, and trickle charger plugged into a.c. electric outlet. Light throws 50-ft. beam 150 to 200 ft. State of battery charge is indicated by pilot balls visible through hole. Case measures 16½x6¼x18 in. Weight is 47 lb.—AVIATION, *May*, '43.

### Power Brake Valve ..... 100

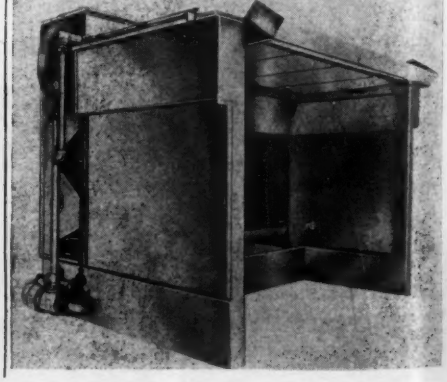
Production has been begun by **Booth Mfg. Corp.**, Burbank, Calif., on a new



power brake valve designed with a cartridge-like assembly to facilitate maintenance. Cartridge unit may be tested in subassembly form before installation in housing. Unit meters from 10 lb. up, requiring no de-booster. Materials used conform to AN specifications. Weight is less than 2 lb.—AVIATION, *May*, '43.

### Paint Spray Booth..... 101

Type FLRS-7 Aqua-Restor paint spray booth, product of **Mayer Mfg. Corp.**, Brooklyn, employs patented super-turbulent chamber and, in operation, side and rear walls are continuously covered with a sheet of water, reducing fire hazards without wetting



# . . to build 'em-or to keep 'em Flying

calls for plenty of skilled work. And that, in turn, calls for plenty of sturdy, well-designed work-benches parked at strategic points throughout the plant.

Our catalog of "Hallowell" work-benches offers for your immediate selection some 1,367 ready-made bench combinations, designed by specialists. Tops are smooth, laminated wood or Masonite. Benches stand rigid without bolting. And deliveries are better than average. Write NOW for "HALLOWELL" SHOP EQUIPMENT catalog.

**STANDARD PRESSED STEEL CO.**

JENKINTOWN, PENNA., BOX 566 · BRANCHES: BOSTON · DETROIT · INDIANAPOLIS · CHICAGO · ST. LOUIS · SAN FRANCISCO

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how FAST, how MUCH

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HOW TO DO intricate metal sanding and finishing jobs the best way. How to do them in *seconds* rather than minutes. And to know *how much* the new "gadgets" of Metalite Cloth cost. All clearly told in this new, illustrated, handy booklet.

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Little Slotted Discs, Pencils and pre-formed Mushroom discs of Metalite Cloth, to fit the Mushroom sanding pad, are shown saving time and money at important wartime production tasks. Just seeing the pictures will suggest their use on dozens of operations in *your* plant.

The book answers myriad questions we have been asked by hundreds of concerns anxious to do present tedious metal finishing jobs faster, better and at lower cost per piece.

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BEHR-MANNING • TROY, N. Y.
(DIVISION OF NORTON COMPANY)
Reliable Coated Abrasives Since 1872


## NEW PRODUCTS

either workers or work. Air cleaning apparatus requires no spray nozzles or moving parts, and pumping is done by low horsepower motor. Unit illustrated is available in various sizes, including equipment for fluorescent lighting.—AVIATION, *May*, '43.

### Chemical "Raincoat".....102

Of exceedingly thin structure, new chemical water-repellent "raincoat" developed by **General Electric Co.** research laboratory, Schenectady, N. Y.,

is being used to moisture-proof ceramic radio insulators. Known as Dri-Film, it is composition which vaporizes below 100 deg. C. Articles to be waterproofed are exposed to its vapor in closed cabinet, then neutralized, if necessary, with ammonia vapor. Treated paper (left in photo) has not absorbed water like ordinary piece (right).—AVIATION, *May*, '43.

### Floor Cleaner.....103

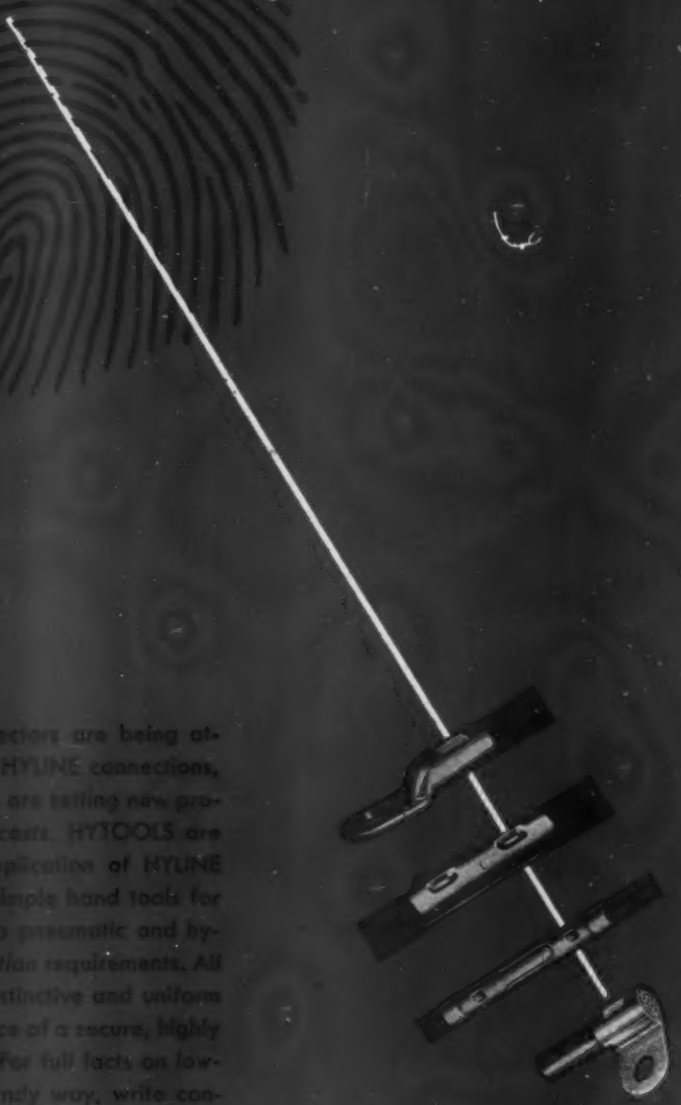
Said to be non-inflammable even under a blow torch, Fibre-Tex, floor cleaning compound made by **Lacey-Webber Co.**, Kalamazoo, Mich., is reported to absorb oils and grease readily. Cleaner is available in 50-lb. cartons.—AVIATION, *May*, '43.

### Fire Extinguisher Case.....104

To indicate any tampering with fire extinguishers, **American - LaFrance - Foamite Corp.**, Elmira, N. Y., has devised cardboard case to be fitted around extinguisher brackets. Unauthorized handling of extinguisher is noticeable as case can be opened only by ripping sealed string.

# DISTINCTIVE

as a *fingerprint*

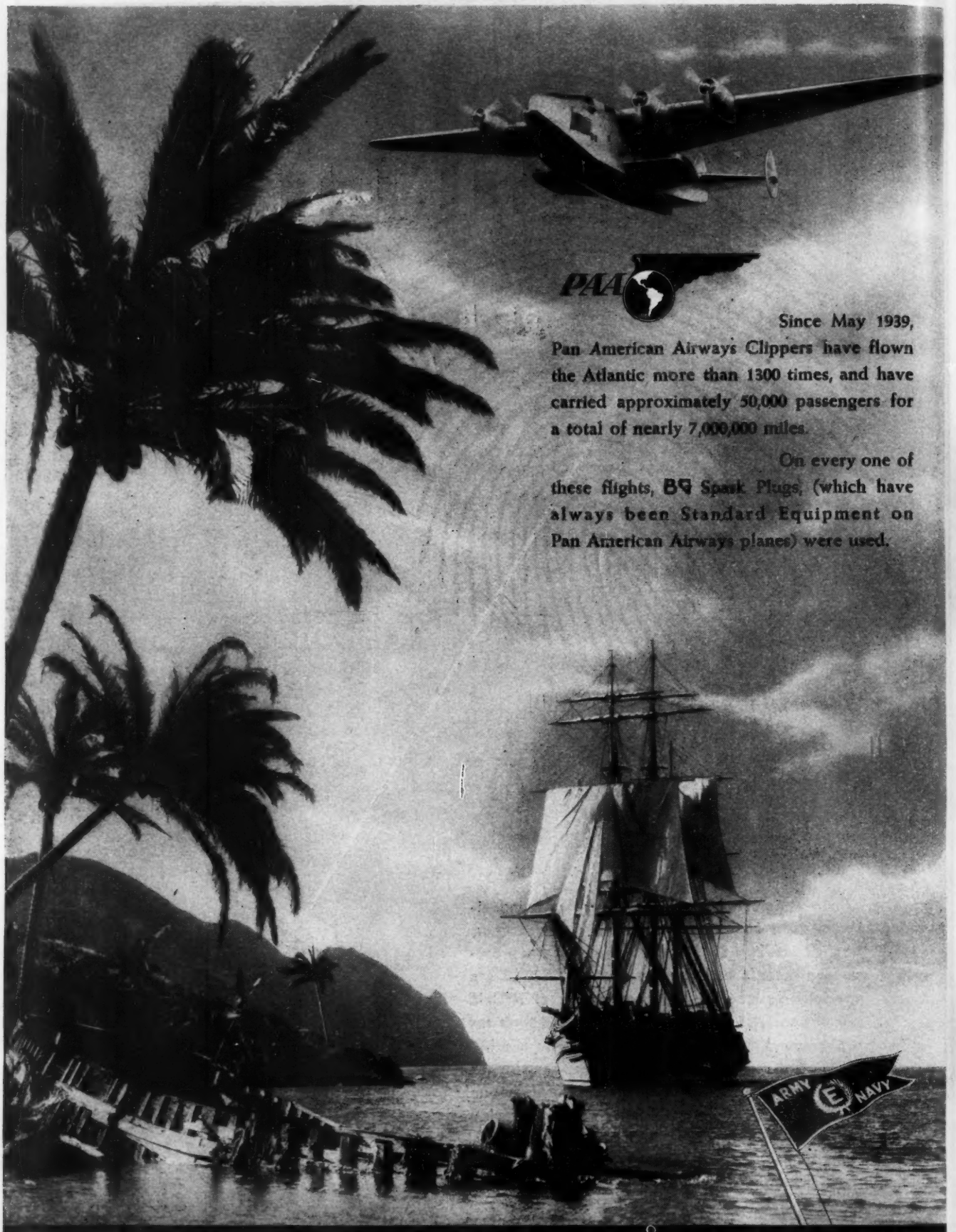


Wherever terminals and connections are being attached to small wires, Burndy HYLUG connections, applied with Burndy HYTOOLS, are rolling new production records and slashing costs. HYTOOLS are specially designed for the application of HYLUG connections . . . and include simple hand tools for rapid, sound application, up to pneumatic and hydraulic presses for high production requirements. All tools indent the lug with the distinctive and uniform Burndy indent . . . your assurance of a secure, highly efficient electrical connection. For full facts on lowering connection costs the Burndy way, write connector headquarters today.

*Headquarters for connectors*

# BURNDY

BURNDY ENGINEERING CO., INC. • 107 EASTERN BOULEVARD, NEW YORK CITY


PAA
Since May 1939, Pan American Airways Clippers have flown the Atlantic more than 1300 times, and have carried approximately 50,000 passengers for a total of nearly 7,000,000 miles.
On every one of these flights, BG Spark Plugs, (which have always been Standard Equipment on Pan American Airways planes) were used.
ARMY E NAVY

# THE BG CORPORATION

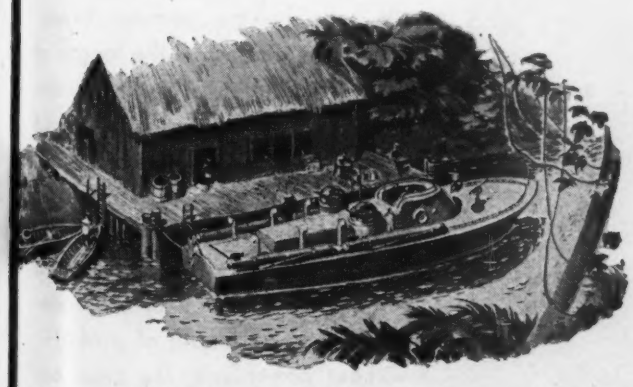
*Contractors to the United States Army, Navy and Coast Guard and Aircraft Engine Builders*

136 WEST 52nd STREET, NEW YORK, NEW YORK

# Once more it's Wooden Ships and Iron Men!

As in the days of John Paul Jones, the Navy's newest arm is composed of wooden ships . . . and iron men. Powered with Packard engines (many equipped with American Hammered Piston Rings), the PT's travel like a terrified hurricane, and speed and spirit are their only armor. December 7 found a fleet of six in the Philippines.

These PT's wrote a glowing page in naval history. Trading punches and giving odds, their score was one Jap cruiser, one 5000 ton (aircraft?) tender, one 5000 ton ship, and 2 landing barges sunk; 2 cruisers damaged, a tanker fired, and 3 dive bombers and one seaplane destroyed. Reefs damaged more PT's than shell fire.



Schedules called for replacement of engines after a few hundred hours, because of the terrific beating they took . . . but bombs had blasted the spares. Repair facilities were primitive. Yet some of these old engines were still serving after 4 times normal life. What a test for the rings! . . . a test they passed with flying colors.

This capacity for service above and beyond line of duty comes from 25 years of foundry, shop, inspection and engineering experience in solving tough ring problems. Where the last ounce of effort is essential, you'll generally find these rings on the job. Koppers Company, American Hammered Piston Ring Div., Baltimore, Md.

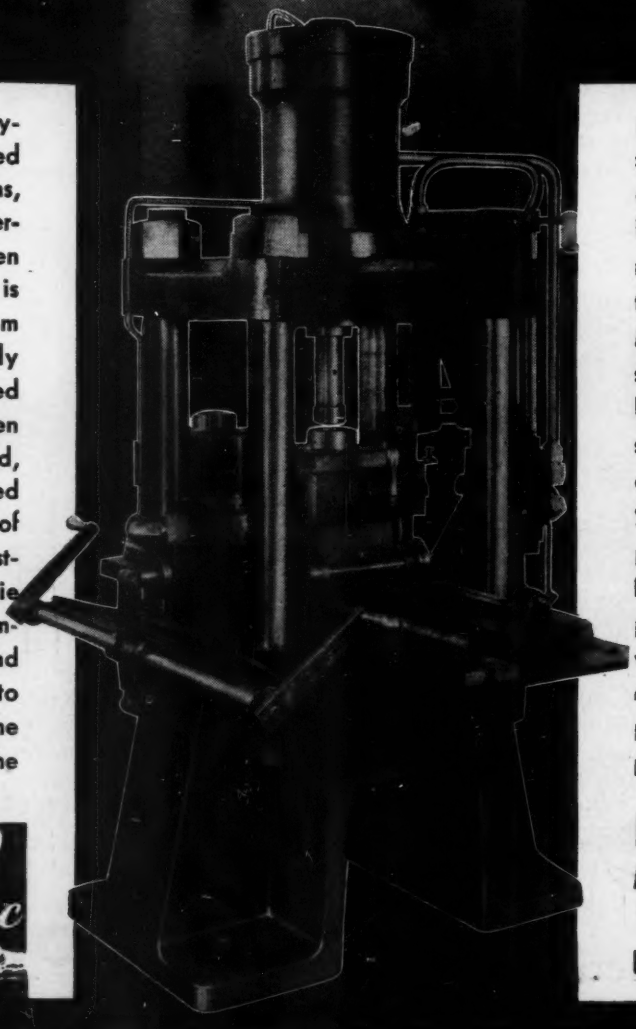
American Hammered Piston Rings

**KOPPERS**

THE INDUSTRY THAT SERVES ALL INDUSTRY

# ANNOUNCING MODEL "K" SERIES Hydraulic Presses

A new type of "Hy-Mac" hydraulic press that may be adapted to capacities up to 150 tons, (identified as a "K" Series) is operated by a separate motor driven power units. It is a press that is ordinarily manually controlled from a four-way valve—automatically cutting-off when the predetermined pressure or tonnage has been reached—ipm. of closing speed, power speed and opening speed as per specifications. The frame of the press is made up of heavy castings bolted together by steel tie rods with the power cylinder assembled vertically on the top and above a base platen 19" (right to left) x 13¼" (front to rear) on the 75- and 100-ton presses. The platen is 1" larger in each dimension on the lighter models and 1" or ½" smaller on the larger ones because of 3" instead of 4" tie rods on the former, and 4½" or 5" tie rods on the heavier types. Maximum daylight—the length of stroke, diameter of cylinder are built to specification, the bore and stroke varying in ratio to the capacity required. The platen is 27" from the floor—height 75-ton press—overall is 82" (varying a few inches one way or other depending upon length of stroke)—without power unit, the press occupies a floor space of 25" x 50"—power unit may be adjacent to press or a remote installation.



*lodel K75 (Illustrated)—*
*5 tons at 2000 lbs. per sq.*
*. on the cylinder—10" bore*
*—9" stroke—here our fa-*
*ilities for making fixtures*
*ere used—the set-up pro-*
*ides for two operators—*
*uttle arrangement.*

**HYDRAULIC MACHINERY, INC.**
12825 FORD ROAD
DEARBORN, MICHIGAN

HYDRAULIC MACHINERY

## Floats and Fuel Tanks of "The Eyes of the Fleet"

*are sealed with*

# PRESSTITE Aircraft Sealing Compounds

*Curtiss-Wright SO3C "Seagull," Scout Observation Bomber equipped with Edo Catapult Type Single Float Gear*

All riveted seams of the float gear of the Curtiss-Wright SO3C "Seagull" Scout Observation Bombers, built by Edo Aircraft Corporation, are sealed with Presstite Extruded Seam Sealing Tape. These floats must take the beating of rough water landings and take-offs and still remain watertight, regardless of the stresses and strains caused by the pounding of open seas.

In addition, Presstite Fuel Tank Sealers are used by Curtiss-Wright to seal the integral Wing Fuel Tanks of these famous Navy ships.

Like many others, these leading aircraft manufacturers have found Presstite Sealing Compounds assure a time and labor saving method of getting a *better* sealing job—and with proven results.

Presstite Sealing Compounds have not only been thoroughly tested in the laboratory, but under the most exacting conditions of flight. They are being widely used throughout the industry today — in applications which include the sealing of:

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| Integral Fuel Tanks | Seaplane Floats |
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Presstite engineers and technicians may well help you to solve your sealing problems, too. Send us you detailed specifications and requirements, and let Presstite recommend the best sealing compounds for your particular needs. Write today.

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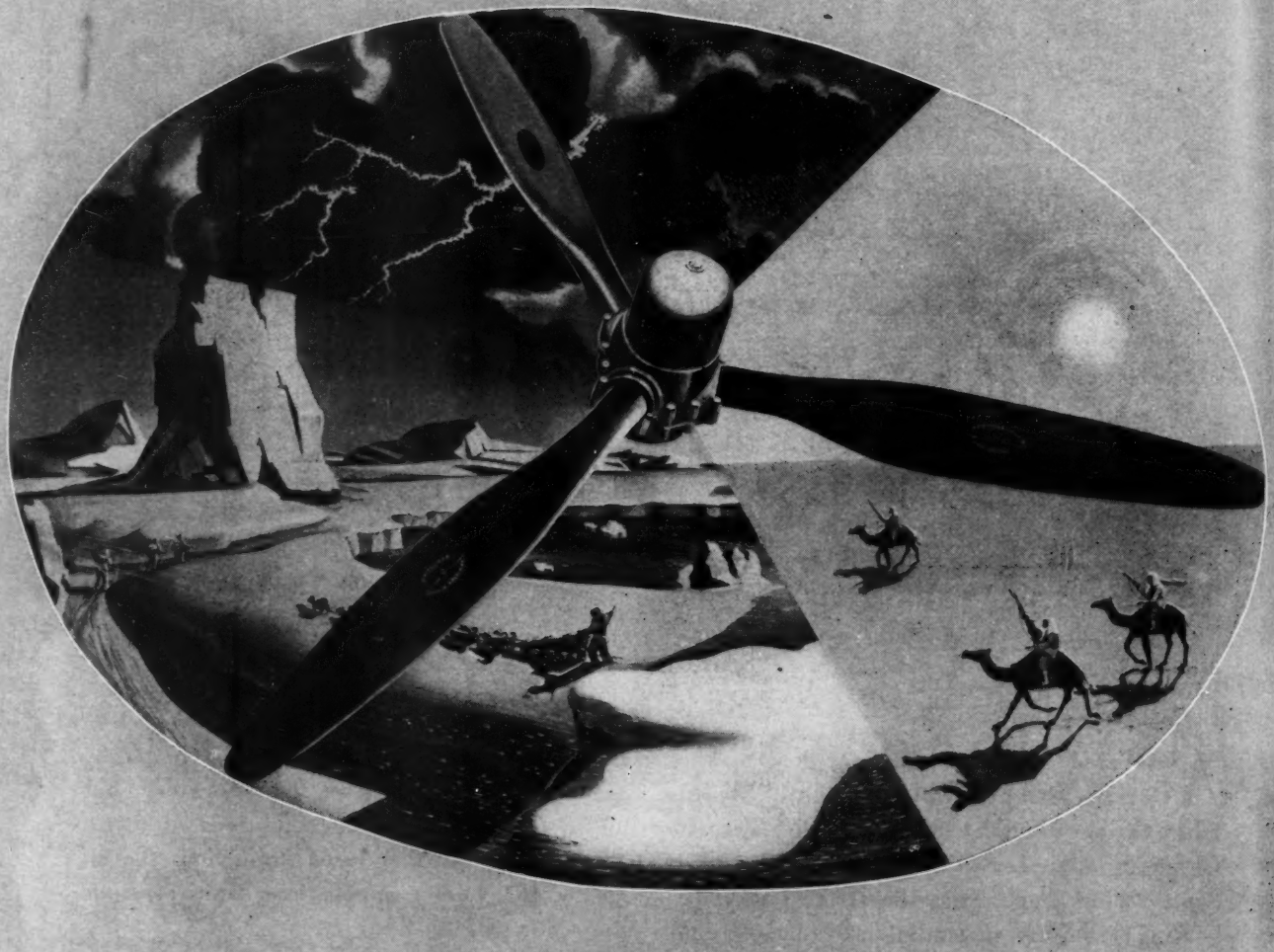
# NEITHER SNOW NOR RAIN NOR HEAT . . . —



Bitter cold, raging storms and blistering heat are all taken in stride by Pan American Airways as it speeds vital war materials north, south, east and west to the far corners of the earth.

Dependable Hamilton Standard propellers, standard equipment on its huge transports, function perfectly through all these extremes of weather.

**HAMILTON STANDARD PROPELLERS**

EAST HARTFORD, CONNECTICUT

ONE OF THE FOUR DIVISIONS OF *UNITED AIRCRAFT CORPORATION*

# The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington E. EUGENE MILLER, New York JOHN FOSTER, JR., New York HERB POWELL, New York

## Aircraft War Production Councils Unite, Establish Washington Office

Los Angeles (Special to AVIATION)—Sixteen manufacturers, members of the East and West Coast Aircraft War Production Councils have united their organizations and filed papers for incorporation of the Aircraft War Production Council of America Inc., in Washington.

"Formation of the national council provides a necessary liaison between East and West Coast manufacturers and promises even greater production of aviation war materials in the future," said a joint statement issued by Glenn L. Martin, president of the new organization and of the East Coast council, and Robert E. Gross, president of Lockheed and of the West Coast council.

In addition to the exchanges of information and pooling of facilities which have enabled Pacific manufacturers to increase production 295 percent since the start of the war, the new council will extend the cooperative use of equipment to the field and also act as a funnel of aircraft information for Washington agencies. In the field it is contemplated that where one manufacturer has set up a service center, it will also be available to all others for the repair of their planes.

Headquarters of the new council has been temporarily established at 1317 F St., NW, Washington. This office will be under the direction of a national general manager, a newly-created post held by Frank F. Russell, who has taken a leave of absence from his position as president of the National Aviation Corp. and director of Bell and Lockheed. His interests thus overlap both former councils.

National problems of the industry were discussed at a three day meeting here as the new organization was formed. Materials are the chief "immediate problem," Pres. Martin said, but manpower is "right behind it."

"The new council discussed at considerable length materials and their allocation and manpower problems," he continued. "We believe we can be of considerable assistance to WPB in solving allocation problems. A committee will take the council's views to Washington."

Mr. Martin also disclosed that an invitation to membership would be extended to the Central Aircraft Council, recently formed under the chairmanship of Ernest R. Breech, president of Bendix Aviation Corp. Organized in Detroit at the request of Army officials, CAC has separate divisions for airframe, engine, as well as component parts manufacturers.

With the union of the two regional groups, the national aircraft production council members are now Aviation Corp., Bell, Brewster, Curtiss-Wright, Eastern Aircraft Division of General Motors, Fairchild, Martin, Republic, Boeing, Consolidated Vultee, Douglas, Lockheed, North American, Northrop, Ryan, and Vega.

Mr. Martin's vice-president is LaMotte T. Cohu, chairman and general manager of

(*Continued on page* 324)

### 7 to 1 in Pacific

Loss of 384 planes by the Japanese as against 54 of our aircraft is reported in the Pacific theater for the first quarter of 1943. Thus, a victory ratio of better than 7 to 1 has been maintained.

## Koppen With Kaiser; Tells of Cargo Plane

Otto C. Koppen, professor of aeronautical engineering at Massachusetts Institute of Technology and director of engineering research for the General Aircraft Corp., has been granted a leave of absence by his company to take a position with Henry J. Kaiser as chief of design in the development of a new type of cargo plane.

Prof. Koppen outlines the proposed plane as an all-wing ship with a span of 282 ft. and gross weight of 175,000 lb. This is the practical minimum size, he said, for carrying all passengers and cargo within the wing. With fuel only, he expects the plane to have a range of 17,000 mi., estimating that fueled for a 4,000-mi. ocean trip, it should carry 68,000 lb. To be made largely of riveted magnesium alloy, the ship is to be powered by four 2000-hp. engines.

Also on leave from General Aircraft is Harris Fahnestock, Jr., vice-president and engineering test pilot, who is working in the radiation laboratories of MIT.

## Air Express Doubled in '42

Upward curve of air express shipments—90 percent ahead of 1941 during the first nine months of last year—continued during the final quarter of 1942. Latest CAA figures indicate that cargoes on commercial lines more than doubled: 23,435,208,925 express pound-miles were flown in 1942, compared with 10,485,058,005 in 1941. Air division of Railway Express reports that "shipments weighing over 100 lb. were routine" and that "about 30 percent of all air express originates at, or is destined to, an off-airline point or moves part way by rail."

## Mareng License to U. S.

Glenn L. Martin has granted the government free license to the Mareng Cell, synthetic rubber self-sealing fuel tank. "Mareng", a designation derived from the words Martin engineering, is one of Martin's most profitable patents. Full rights will revert to the company after the war.

Martin first developed the cell as a thin-walled fuel tank in 1919. The chief advantage was that it could be stuffed into, or withdrawn from, its cavity through a small opening. The self sealing feature, introduced in 1940 under direction of Reid B. Gray, Martin's chief of laboratories, causes it to seal itself instantly after penetration by bullets.

Martin has successfully tested larger tanks for converting ordinary box cars into fuel carriers.

Officers of the new Aircraft War Production Councils of America, Inc., are (left to right) LaMotte T. Cohu, vice-president; Glenn L. Martin, president; and Frank F. Russell, general manager. Mr. Russell will be stationed at national headquarters in Washington as liaison executive to WPB and the armed services.

## Knox and Stimson Pledge More Planes For Pacific; To Treble Navy Combat Craft

American naval air strength will increase tremendously during 1943, and more planes will be sent into the Southwest Pacific, according to statements by Secretary of the Navy Knox and Secretary of War Stimson.

Speaking at the recent launching of a naval vessel, Mr. Knox outlined building progress since Pearl Harbor and announced that "our effort this year will be marked by two special accomplishments upon which we have bent every energy and all our will—airplane carriers and destroyer escorts. The number of carriers, both large and auxiliary, completed in 1943 will multiply many times our total carrier force at the end of 1942.

"As to aircraft," he continued, "the number of combat planes was more than doubled between Pearl Harbor and the end of 1942. Nevertheless, in 1943 Navy combat planes will more than treble in number. Naval fighter planes, specifically, will multiply by five. Other combat types, principally observation planes, will decline in importance. But bomber production will be four times the number in the Navy air arm at the end of 1942."

Answering complaints, officially acknowledged a week earlier by OWI Director Elmer Davis in a radio report to the nation, that too few planes were being sent to the Southwest Pacific, Secretary Stimson explained that "the allocation of a limited supply to meet very large demands is a very difficult task."

But, Mr. Stimson promised, "the needs of the Southwest Pacific are being kept constantly in mind. There will be an increasing flow of military supplies, particularly airplanes, to that war theater."

On the receiving end somewhere in New Guinea, Lt. Gen. George C. Kenney, commander of Allied air forces in the southwest, remarked, "I'll be pleased when we have the Jap planes outnumbered five to one. In daily combat we are doing pretty well, but the Jap has too many airplanes around to suit me. We are forced to shoot down four or five to one to keep the score straight."

### United Airlines Files Passenger Rate Reduction

Washington (AVIATION Bureau)—United Air Lines has filed notice of a substantial passenger-fare rate reduction with the Civil Aeronautics Board. The company says that its proposed reductions will total about $1,600,000 annually and that new fares generally will be no higher than first class train travel costs and in numerous instances they will be lower. Pres. W. A. Patterson said the new rate schedule was filed as of May 1 with a proposed effective date of June 1.

He announced that the proposed reduction is attributable to the sharp wartime increase in the number of passengers per plane, to greater utilization of equipment, and to the company's desire to reduce rates as rapidly as possible consistent with sound business. He pointed out that United has taken a 40 percent cut on mail pay (under the .3 mills per pound mile order) and will receive $1,700,000 less annually for carrying the same amount of mail.

United's reduction notice is significant. Immediately after CAB issued its recent order to operators to show cause why their rates should not be reduced 10 percent, many airline managements prepared to file answers with figures showing that they should be allowed to keep their high earnings in reserve for postwar rehabilitation. It must be assumed that United decided against this policy and that other lines may take the same course.

CAB spokesmen had no comment, except to say that its show-cause order calls for a 10 percent reduction in passenger fares and that United's announcement does not claim to have made that much of a reduction. Indications are that the Board is going to demand the full recommended reduction, other than in cases where good counter reasons can be given.

### War Will Give Us World Airport System

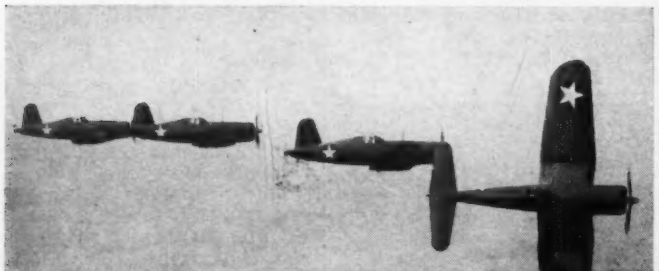
Washington (AVIATION Bureau)—When war news restrictions are lifted, a surprisingly extensive United States airbase system will be revealed, reports L. P. O'Connor, Pan American port engineer.

A subcommittee of the House Naval Affairs Committee is already studying a postwar strategic plan which will serve as a guide for our peacemakers when they ask for landing concessions. Many bases have already been built in other countries, and our needs for commercial airlines will also be considered in the peace treaties.

The enemy is also at work, especially in the Pacific, on costly bases which with victory will become the property of the United States, England, and Holland. If the Japs succeed in cutting a base out of the rocks of Kiska island, we will get it. And we will also get such bases as those at Munda and Vila.

We already have Guadalcanal's Henderson field, initially built by the Japs.

Scores of other airports are being hewn out of Caribbean jungles and in Central and South America. They are located every 500 mi. to serve as intermediate stops on the supply route to Africa via the Brazil hump. They should all have permanent commercial value.



*Official Navy Photo*

TESTING THEIR STING

Navy F4U-1 "Corsair" peels off from formation during combat-practice flight. Recently added to sea arm's anti-Axis sky lineup, powerful high-altitude Vought craft are now made not only by United Aircraft but also by Goodyear and Brewster.

## Washington Increases Operations Authority Of AAF Commanders in Combat Theaters

Washington (AVIATION Bureau)—Headquarters of the Army Air Forces still tells field commands *what* to do—but not *how* to do it. For delegation of more powers to the combat theaters is announced.

It is noted that this development is not a shake-up but a natural growth of the Air Forces. Nor can it be linked in any way with the recent promotion of Gen. Arnold. In short, the AAF believes that field commands now have had sufficient training to carry out the policies of the high command without general supervision from headquarters in Washington.

This represents a third reorganization of AAF headquarters since it was established on Mar. 2, 1942. The first reorganization was designed to speed up training, to procure tremendous quantities of equipment and supplies, and to increase personnel. The second stressed the Material Command and the Flying Training Command. Now the third, a streamlining process, places emphasis on combat theaters.

All control, however, continues to come from Gen. Arnold and all responsibility rests with him. The Chief of Air Staff, Maj. Gen. George E. Stratemeyer, carries out Arnold's orders, acts for him in his absence, and coordinates the activities of the Air Staff, Commands, and Special Staff (air inspector, air surgeon, etc.). Under the new organization there are three deputy chiefs, instead of one: Brig. Gen. T. J. Hanley, Brig. Gen. La Verne Saunders, and Col. William E. Hall (recently nominated for brigadier general).

Newly designated are the officers of the six Assistant Chiefs of Air Staff: Maj. Gen. Oliver P. Echols (Material, Maintenance, and Distribution); Maj. Gen. Barney McK. Giles (Operations, Commitments, and Requirements); Brig. Gen. O. A. Anderson (Plans); Brig. Gen. R. W. Harper (Training); Col. (nominated for Brig. Gen.) J. M. Bevans (Personnel); Col. E. P. Sorenson (Intelligence). These Assistant Chiefs of Staff translate the over-all policies of the AAF (determined by the Commanding General) into whatever is needed in terms of men and machines. They direct acquisition of the manpower and allocate machines for combat use.

Brought under the staff by the reorganization are the directorates of Air Defense, Bombardment, Air Support, Base Services War Organization, Individual Training, and Photography and parts of the directorates of Communications and Weather, War Or-

ganization, and of Movement.

A new Office of Special Projects has been created, headed by Col. F. Trubee Davison, former assistant chief of the air staff. And a new command, Flight Control, has been formed under Col. Samuel R. Harris to absorb the functions of the Air Traffic and Safety Communications, and Weather Services. Maj. Gen. Follet Bradley becomes air inspector.

Gen. Echols is succeeded as commanding general of the Materiel Command by Brig. Gen. Charles E. Branshaw. Gen. Echols has been given the supervision of all functions of the Materiel Command, the development and procurement of aircraft, equipment and supplies, the Transport Command, and the Air Service Command.

## Elect Bellanca Officers

The board of directors of Bellanca Aircraft Corp. has elected the following company officers: Col. John H. Jouett, president; Lessiter C. Milburn, executive vice-president and general manager; S. Samuel Arsht, assistant to the president and treasurer; Harlan L. Thompson, secretary; James R. Morford, secretary to the board; and Willard R. Yarnall, comptroller.

## AAF Accident Report Brings Congress Charges

Washington (AVIATION Bureau)—Under increasing pressure for more accident publicity, the Air Forces recently made a frank statement on total fatalities during nine months, January through September of 1942, and was then criticized by some persons and agencies for saying too much.

The total figure of 1,700 deaths from training during the three-quarter period looked rather startling in the headlines. The sharp edge comes off, however, when there is comparison with numbers of men and flying hours involved.

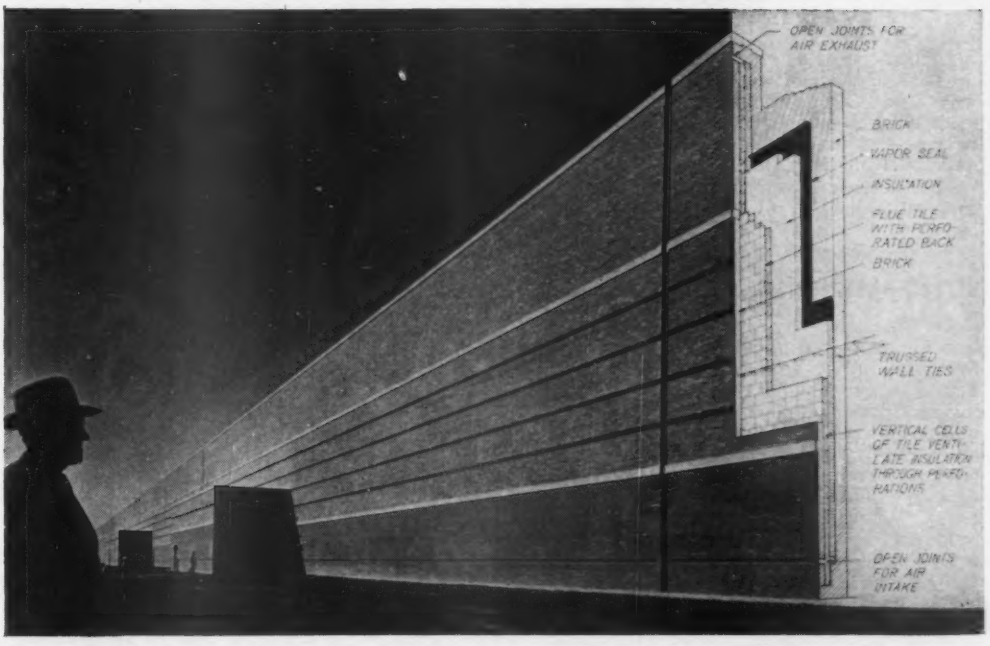
The figure would have been much larger if it had included fatalities in ferry, cargo, and combat operations. In fact, accidental fatalities are in high ratio to combat deaths in all the belligerent air forces.

Concurrent with the Army's announcement, serious but thus far unsubstantiated charges have been placed on record in Congress to the effect that AAF accident statistics have been twisted to present a picture more favorable than true, and some cases are alleged to have been actually suppressed. The Truman Committee has taken considerable testimony on this subject and will take more. Air Forces spokesmen said they would comment on the charges only in testimony before the committee if and when called.

Continuing its effort to show the relationship between number of accidents and the vastly increased number of men and flying hours, the Air Forces points out that, nevertheless, a comparison between the ten-year period 1930-1939 and the nine-month period in 1942, shows a decrease of almost 10 percent in the rate of accidents per 1,000 hours flying time. During the 1942 period, there was only one fatal accident for every 1,750,000 mi. flown and only one fatality for every 850,000 mi. There were 75 accidents of all types for each 100,000 hr. flown; only 8 of those were fatal.

Investigation shows 78.7 percent of accidents due to personnel error; 14.5 percent to material failure; 3.3 percent to weather and terrain; and 3.5 percent under the "undetermined" head.

## Douglas Plant Feature Is "Breathing" Wall




Air intakes at bottom and exhausts at top of this wall of new Douglas Oklahoma City plant, built by The Austin Co., keep down interior temperatures and make air conditioning system more effective.

Oklahoma City (Special to AVIATION)—Less than a year after ground-breaking for the new Oklahoma City assembly plant, production of Douglas C-47 *Skytrain* cargo planes had been started, it was revealed as Army Engineers accepted the plant from The Austin Co., builder.

As the first section was completed last November 1, Douglas moved in the first group of locally trained employees to start fabrication of subassemblies. As more space was made available, this process was repeated, with the result that production was under way when the plant was completed.

A new type "breathing" wall was conceived by Austin engineers to increase the efficiency of the air conditioning system and yet conserve strategic materials. Without glass and steel materials used for insulation in other buildings, the Oklahoma City plant has the same insulating value as an 80-in. brick wall, although it is only a fraction as thick.

Over 50 ft. high, the new type wall is ventilated through open vertical joints in one course near the top and in two courses waist high near the bottom of the outer brick work. Hollow ventilating tile serves as a flue through which air circulates vertically between these open joints. The tile has a perforated back allowing a 4-in. blanket of rock wool insulation to "breathe", thus preventing condensation. The wool is held in place by light trussed ties—the only steel in the wall—which hold the many layers together and make it shatter resistant.

A. D. Engle was project manager in charge of design and construction for The Austin Company and Maj. E. A. Cornell was area engineer for Army Engineers. C. C. Pearson is plant manager for Douglas, and Maj. Geo. T. Chadwell is resident Air Forces representative.

## Industry Notes

Bantam Bearings Corp., South Bend, Ind., producer of anti-friction bearings as a subsidiary of The Torrington Co., Torrington, Conn., has merged with its parent company and will now be known as The Torrington Co., Bantam Bearings Div. . . . Standard Aircraft Products, of Dayton, Ohio, which has been supplying control instruments and other technical equipment for Britain's *Sterling* and *Lancaster* bombers, has opened an eastern plant in New York City . . . Aviation Equipment & Export, Inc., of New York, with subsidiaries in Brazil, Argentina, Britain, etc., has officially changed its name to Aviquipo, Inc. Pronounced A-vee-keep-o, this designation was first used as the company's cable address. . . . To reduce fatigue and improve production efficiency, the Glenn L. Martin Co. has adopted two ten-minute rest periods per day for its workers. . . . PCA now has a staff of 18 lady expediters, one for each of the primary cities of the airline's routes. They facilitate various operations.

## Wood Increase Planned

To care for the AAF's expected requirement of 300,000,000 sq.ft. of boxing and crating material during the remainder of this year, WPB's Lumber and Lumber Products Div. plans an increase in pro-

duction of softwood plywood.

Output during the first quarter of '43 has been 30 percent behind last year due to bad weather and shortages of manpower and logging equipment, but the Softwood Plywood Industry Advisory Committee believes the deficit can be made up with suitable logs available and with the 10 percent increase over ceilings granted, April 15, on Douglas fir.

## Versus Absenteeism . . .

An incentive-pay program is being promoted by the WPB for trial in a few aircraft plants as a means for increasing production while relieving manpower problems such as absenteeism. The scheme, if effected, would call for percentage bonuses on output. . . . Where the worker-attendance records are bad, the Navy plans to withhold its "E" awards. . . . Cessna Aircraft has a $250-per-week prize drawing, employing workers' badge numbers. To win, an employee must show a perfect attendance record for the foregoing week. . . . Another move against absenteeism is reported by the aeronautical division of the Otis Elevator Co., Harrison, N. J. This firm has had the L. Bamberger department store establish a shopping center in the plant, open each Friday. . . . Donald Bernstorff, assistant flight director at the Linden, N. J., Eastern Aircraft plant, himself formerly with the AVG in China, hires discharged Army and Navy men returned from the war fronts. He points to their salient effect in increasing production, urges other plants to hire them. . . . The common cold stands as a primary target in reducing absenteeism, reportedly causing a loss of some 90,000,000 work-days annually.

## Patterson Sees Postwar Air Route "Scramble"

As many as ten airlines may be competing in transoceanic service between this country, Europe, and Africa in the "scramble" for world air routes that will accompany readjustment of the transport industry to peace, W. A. Patterson, president of United Air Lines Transport Corp., predicts in his annual report to stockholders. He also cautions that companies contemplating foreign services maintain close government ties.

"There has been some discussion about postwar government ownership of transoceanic airlines," he said, "the theory being that we can compete with foreign-owned ocean airlines only with a single, government-controlled monopoly. However, nothing has developed in conversations thus far to cause any worry."

Neither is there any evidence that the government is thinking of assuming control of domestic lines, largely, he pointed out, because their efficient wartime operation has permanently squelched rumors of national ownership.

Within ten years, Mr. Patterson predicted, 80 percent of first class passengers, 75 percent of first class mail going more than 450 mi., and 50 percent of parcels now being mailed would be carried by domestic lines.

Such expansion would require the U. S. to increase its pre-war fleet of 350 planes to 5,250. But the end of railroads and steamships is not in sight, he said, for commercial use of glider trains is still far distant.

## Navy Production Movie

To increase production of plants converted from peacetime operations to aircraft work, the Navy Bureau of Aeronautics is presenting a series of films on successful methods in aircraft factories.

Nine motion pictures, produced by Walt Disney, cover forming methods, blanking and punching, bending and curving, riveting, mock-up and tooling, lofting and layout, heat treatment, welding, and template reproduction. Since the information is restricted, the films may be shown only with the permission of the bureau.

## Russell, Schiller Pass

Word comes of the death, at Fort Jay, Governors Island, N. Y., of AAF Brig. Gen. Clinton W. Russell, liaison officer for the War Department. Learning to fly in 1916, he became commanding officer of the Army's World War I flying school at Waco, Tex. In '39, he became chief of staff, GHQ Air Force, at Langley, Field, and later chief of staff, the Air Forces Combat Command, following which he was on overseas assignment.

Meanwhile, Montreal reports the death at Bermuda of Capt. Clarence A. "Duke" Schiller in a crash landing at night while flying an RAF Ferry Command plane. A veteran of the RCAF in the last war, Schiller was most renowned for his rescue, a decade later, of the *Bremen* flyers.

## May Fly, Rent Light Craft

Washington (AVIATION Bureau)—Owners whose light planes were frozen by WPB limitation order L-262 in January may now rent them to students qualifying for essential flying jobs, provided the candidates file special applications. W. L. Jack Nelson, chief of WPB's aircraft priorities branch who released this information, emphasized that L-262 does not prohibit an owner from flying his own plane so long as it is not rented, sold, or transferred without authority.

### AWPC Councils Unite

(*Continued from page* 321)

Northrop. Directors, besides Messrs. Martin and Cohu, are J. Carlton Ward, Jr., (Fairchild), Lawrence Bell (Bell), Mr. Gross (Lockheed), and T. Claude Ryan (Ryan).

### Cite Capital Functions

Washington (AVIATION Bureau)—Specific functions to be handled by the new AWPC of America, headquartered here, will include: 1. Interchange of information and facilities of all companies, including non-members, to avoid duplication and delay; 2. Service on research and information on war production in cooperation with the armed services and government agencies; and 3. Expedition of pooling facilities, plans, practices, and data for maximum production.

In their joint statement, Messrs. Martin and Gross said, "We have needed a fully representative office in Washington which could extend to the armed services and the WPB the immediate help of the entire aircraft industry and at the same time keep the manufacturers abreast of national policies of the government groups."

Absent from the member list at this time are Grumman Aircraft and United. However, representatives of United attended the Los Angeles meeting at which the new Council was formed, and spokesmen of the Council said they expected United and others would join the group. United had not been a member of the Eastern Council. It was not clear whether new members would join the national body directly or one of the original regional councils.

## ★ ★ ★ ★ SPOT CHECKING ★ ★ ★ ★

**Allied planes** showered bombs on the Continental Nazis on all but three of March's 31 days. The month's tonnage of dropped bombs was put at 15,000. Not much more than twice that weight of "eggs"—37,000 tons—was loosed in the whole of '42.

**That the** United Nations have superiority in quantity production of arms was admitted in a recent article by Nazi Maj. Gen. Leyers, who calls upon Germany for new inventions to offset this advantage.

**It is revealed** that Ryan trainers, captured in Java, are being used by the Nips in their pilot-training program at Batavia.

**Britain** is reported to have produced four times as many heavy bombers during February as it did in that month of '42.

**In battering** the Mareth Line, American planes on March 30 alone made 1,399 sorties (single-plane assaults).

**Our first** glider-pilot combat school has been opened at Bowman Field. Training in the 21-week course is similar to that given paratroopers.

**Capt. Joseph H. Hart,** of PAA, recently flew the South Atlantic twice in 24 hr.—a single-day round trip. Natal was his takeoff point, and he "turned around" at an unnamed African base, where but 50 min. was required for refueling and servicing. The plane was a Boeing *Clipper*.

**Perfection** of a colloid-combination chemical to purify sea water and thus enable ocean-downed airmen to survive adrift for 25 days is reported by Dr. Alex Goetz, of the California Institute of Technology. A waterproof container of cigaret-package size will, he says, "clear" two quarts of water.

**Calculation** by Sir Archibald Sinclair, British Secretary of State for Air, has it that more than 2,000 German war plants were hit in 1942.

**Gulf Oil** announces completion at Port Arthur, Tex., of a new Houdry catalytic cracking unit for the production of 100-octane aviation gasoline. Meanwhile, work continues on other projects to increase output of this fuel.

**"Duke" Andrew Reid** has returned to Brewster as senior inspector. Well known veteran of World War I and member of the Early Birds and Institute of the Aeronautical Sciences, he has spent 30 yr. in aviation with such firms as Curtiss, Standard, Aeromarine, L. W. F., and Szekely.

## IAS to Establish Library and Museum

On property at Sands Point, Long Island, N. Y., given to it last year by Mrs. Daniel Guggenheim, the Institute of the Aeronautical Sciences will establish an aeronautical library and museum. Columbia University, joining the Institute in a program designed to make Sands Point an aeronautical center, will use the Minta Martin laboratory building for research.

While the Institute's project of establishing an aeromedical laboratory has been postponed until specialists are relieved of military duties, present plans for the library and museum call for organization of a branch of the Paul Kollsman Library of the Institute, which now makes free book loans to people throughout the country. Also planned is the collection of pictures, models, and relics of famous flights.

"In the press of wartime production, the value of fundamental aeronautical research and study should not be neglected," the *New York Times* commented on the Institute's announcement of its union with Columbia. "Both aeronautical progress and scholarship will be served by the new undertakings at the Long Island center where, nearly two decades ago, the Daniel Guggenheim Fund for the Promotion of Aeronautics was created."

## Arnold Made Full General; Other Airmen Promoted

Unanimous approval by the Senate of President Roosevelt's nomination has made Lt. Gen. Henry H. Arnold, commander of the AAF, the first air officer to become a full general and the fourth now on active Army duty. Washington military circles interpreted the move as fully recognizing air power's place on the world's fighting fronts.

The War Department stated that the elevation was "necessary from a command standpoint and also as a recognition of outstanding accomplishments." By the end of the year 2,450,000 men and 900 fighting and bombing squadrons are expected to be under Gen. Arnold's command.

Also promoted by the President were Brig. Gen. Claire L. Chennault, commander of the newly activated 14th China Air Force, and Brig. Gen. Clayton L. Bissell, commander of the 10th Air Force in India and Burma, who were named to major generalships.

Lt. Gen. Delos C. Emmons, commander of the Hawaiian Department, has been awarded the Distinguished Flying Cross for "extraordinary achievement while taking part in flights in furtherance of the development and expansion" of Army air power.

*Army Signal Corps Photo*

**GEN. HENRY H. ARNOLD**
Aviation's first four-star officer

## Texas Celebrates Aviation Week

Highlight of Texas Aviation Week, proclaimed by Gov. Coke R. Stevenson for May 3 through 8, will be a conference on production, materials, personnel, and training problems at the Agricultural and Mechanical College, College Station, May 6, 7, 9. A similar conference attracted 400 people last year.

This year's session will include discussions on vocational and college training by E. L. Williams of the college and C. T. Reid of Douglas; plastics and plywood development by H. J. Hansen, Technical Plywoods, Inc.; press relations, Andrew DeShong, North American; and production tooling problems, M. C. Weber, Consolidated Vultee Texas plant. Other talks will be given by William B. Stout of Consolidated and staff members of *Southern Flight*.

## Domestic Flying Studies Urged by Gorrell of ATA

Studies of the domestic side of postwar flying by CAB have been advocated by Col. Edgar S. Gorrell, president of the Air Transport Assn. of America, in an announcement asking investigation of the advantages of carrying all classes of mail by air wherever delivery would be speeded, the transportation of cargo by air, the development of meteorological services, airways, and airports, and the improvement of navigation and communication facilities.

Calling attention to the fact that the industry would be able to carry most mail by air after the war, Col. Gorrell

## The Washington Windsock

By BLAINE STUBBLEFIELD

**Somebody forgot** or didn't get around to notifying one of the airlines of the Transport Command's decision that it must decorate its planes with Army paint before operating them abroad. When the British saw an American domestic airliner sashaying across the country, they gulped. "I say, what nonsense is this?"

**Canadians are alarmed,** say the newspapers, about extension of American flying in their western reaches. But they are not *really* alarmed. It is just a parliamentary committee's way of calling attention to an irregularity. One of our airlines, operating over Canada under a Transport Command contract, flew its planes around with company markings before Army paint was applied, and one company official made an ill-advised remark that "we are here to stay."

**The expected air mail squeeze** has started. Mail is being put off to make room for strategic cargo. Some remedy may be applied by the time you read this. Trouble is that Army Priorities doesn't know which mail is important and which isn't. It was a question whether to ask senders to affirm on covers that contents were essential to the war. This would make a new sorting problem for the Post Office. Another possibility would be to put all short-haul air mail on the trains. The airlines do not want the public to feel that air mail space is being rationed, but restrictions will come if the war lasts.

**A joke on bankers** turned up in CAB. It seems that some of the Wall Street boys got together and applied for one of the famous routes out of Miami to the Caribbean. The examiner said: "And I suppose you have the necessary airplanes." "Not yet," said the chief banker, "but we'll get them." "Where?" asked the examiner. "Wherever other people get airplanes," said the chief banker, "we have the money."

**Some promotion-minded men** put their heads together and decided to pressurize the Army on the use of diesel aircraft engines, their object being to make some money. AAF engineers told them gruffly that splendid things might be done with diesel engines—come peace.

**Which side are you on?** Rear Adm. W. H. P. Blandy reveals that another United States battleship successfully defended itself against a powerful Japanese air attack, shooting down about one-third of the attacking force. He implied that the battleship is not vulnerable to an attack. But about the same time a high AAF general, just after the total destruction of that Jap fleet in the Bismarck Sea, said he could sink anything he could find—including battleships.

**In need of knowledge,** a man in CAB sent to another government agency for a secret document which he thought would tell all. Two uniformed guards, each with a brace of six shooters, delivered the great military secret to his desk. Our man read it through—and he swears that he could have found every line of it in the *World Almanac*.

**What kind of airplanes** do the transport companies want after the war? Several of the manufacturers have been prying into official cost and performance records in an effort to learn what kind to try to sell to them.

**The ground rules** of war have been changed by airplanes. Troops and sailors off sunken ships, in the water or on barges and floats, are unable to surrender to enemy aircraft overhead. Yet because they are still potential belligerents, who might rejoin their forces, it is fair play to machine gun them from the air. This is being done by both sides. It's a sad new result of flying, which started as one of the finest of the arts.

# *Making planes* **FLY** *with their feet on the* **FLOOR**

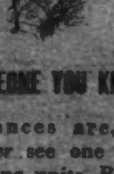
**Not so long ago, the only way to check the operation of an airplane was to test it in flight. If it had to be done at the risk of a pilot's neck — well, in *those* days, what were test pilots for, anyway?**

**HydrOILics has changed that!**

**For example, the HydrOILic Test Stand pictured here checks the whole hydraulic system of an airplane — *while the plane is safe on solid ground.* It's a mighty important test, because ailerons, rudders, elevators, bomb bay doors, landing gear, and even the propeller pitch controls of modern aircraft depend on the plane's hydraulic system for safe, smooth, accurate operation. Other HydrOILic test stands check other phases of airplane performance on the ground, for safety in the air.**

**Aviation is only one of many fields in which Denison Engineers have applied the exceptional *smoothness, flexibility and controllability* of oil hydraulic power. If you have a problem — in either your product or your production — our engineers will be glad to hear from you.**

**The Denison Engineering Company, 1166 Dublin Rd, Columbus, Ohio.**



**SOMEONE YOU KNOW . . . .**

**Chances are, you'll *never* see one of these testing units. But *someone you know — your own son, perhaps* — may be among the thousands of air force heroes who owe much of their daily safety to its service.**

INDUSTRY'S NEW RIGHT HAND FOR AVIATION

DENISON EQUIPMENT *in* APPLIED Hydr ics

TRADE-MARK

warned that "unless someone soon starts definitely to survey the possibilities, the ultimate accomplishment of an admittedly desired objective may be needlessly and too long delayed." As to transport, the Colonel pointed out that "the great bombing raids that are being carried out every day are nothing more nor less than costly and terrifying experiments in the transportation of cargo by air."

In the proposed study on meteorology, he recommended investigation of steps necessary to develop world-wide services, international exchange and coordination of information, encouragement of collaboration between private and government meteorologists, and increased research.

## Wilson of NAA Outlines Postwar Air Program

Gill Robb Wilson, president of the National Aeronautic Association, has presented to the Interstate and Foreign Commerce Committee of the Congress, at its request, a statement designed to give direction to the thinking of the American people on the broad field of postwar aviation at home and abroad. It recommends reciprocal airline agreements with other nations; mutual agreement on location of air bases; freedom of the air over the seas; establishment of international air patrol over the open seas; and sovereignty of all nations in the air over their domains.

Wilson would have foreign ownership of any airline in the Western hemisphere declared contrary to the Monroe Doctrine. He recommends that the Civil Aeronautics Act be amended so that the board and the Administration would report to the Congress, and he favors re-creation of an independent air safety board.

## Services Division Work Summarized

Regional meetings organized by the Management Branch of the War Department for executives in war industries, have met with success in "bringing about a closer understanding between the War Department, the Army, and those who are forging the implements for victory on the home front of production," according to a summary of the work of the War Department Industrial Services Division, of which the Management Branch is a section.

Under the direction of Maj. Keith Lindsay Morgan, the Management Branch, formed in August 1942, has held five meetings in various parts of the nation and plans a sixth in Ohio this month. Robert P. Patterson, under secretary of war, has offered and answered questions at these gatherings, which have been opened with radio broadcasts.

In releasing this information about the Management Branch, Col. A. Robert Ginsburgh, chief of the Industrial Services Division, gave a summary of the division's work in the 18 months since its founding. Most publicized activity is the awarding of Army-Navy "E" pennants. The Services Division has also circulated motion pictures and production communiques to war plants and supervised the publication of magazines for ordnance and aircraft workers. Information has been sent to trade and labor editors and material supplied for radio programs in the effort to reach "the human factor" in war production.

## Maintenance and Utilization Efficiency Nearly Double Lines' Capacity, Says OWI

With almost half as many planes, commercial airlines are carrying almost as many passengers as they did before the war, according to a report on the nation's land and air transportation systems issued by the Office of War Information.

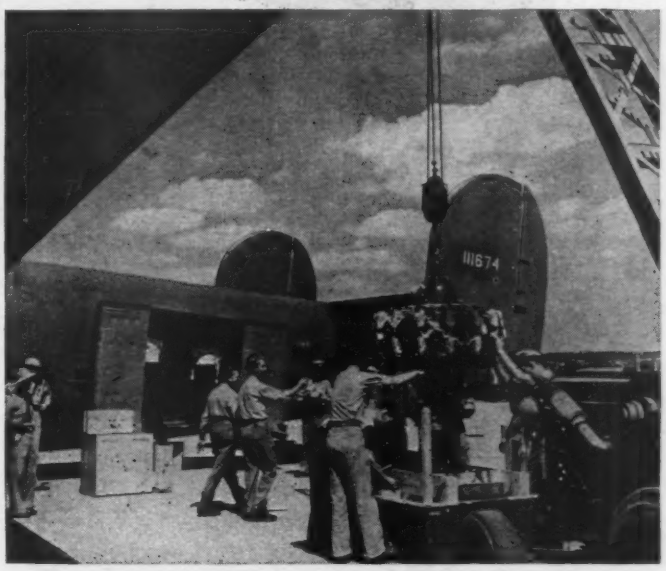
"The battle of transportation in the continental United States—at a crisis at Pearl Harbor time," it says, "is now being won, and the war and the necessary civilian transportation load is being carried. The victories, however, are not necessarily permanent."

Regarding the "air picture," the survey estimated that "of the 434 planes operated commercially within and beyond the continental limits of the United States by United States airlines before Pearl Harbor, almost half have been taken over by the armed services, chiefly by the Army's Air Transport Command. Those planes which are still operated by the commercial airlines are carrying only slightly fewer passengers than were carried by the whole fleet before the war."

Despite this loss of equipment, the report continues, some lines are flying even more passenger-miles. "This has been made possible by greatly improved maintenance facilities and by increased utilization and efficiency. Before the war the average daily mileage of a commercial plane was well under 1,000 mi. Now it is about 1,100."

While airlines are maintaining contract transportation services for the Army and Navy, "almost no all-cargo planes are operated commercially at the present time." Private flying has been practically restricted to Civil Air Patrol operations, OWI says. War Training Service has absorbed a great many civilian pilots, who have become instructors.

While other forms of transportation have suffered severely from loss of manpower to the services or better-paying jobs, aviation has had little comparative difficulty. Selective Service boards have been liberal in granting deferments to airline personnel.



This photo of Consolidated C-87 "Liberator Express", about to "take on" aircraft engine for shipment, accompanied transportation report. Pointed out OWI: "This craft carries one of greatest human or cargo loads of any plane now in mass production."

## Calling Names

**Mrs. Mary Parker,** magazine feature writer, has joined American Airlines' publicity staff.

**Peter Altman,** for the past several years director of the manufacturing research department for Vultee, has resigned to form a consulting and development service with offices in Detroit.

**E. C. Bullard,** vice-president and general manager of the Bullard Co., was recently honored by a Foremen's Club dinner, marking his 25th year with the firm.

**A. L. Golay** is now with the staff of Kold-Hold Mfg. Co., refrigeration application engineering and service firm.

**Robert E. Lees** has become director of economic research for TWA.

**Harold S. Kinsley,** vice-president, and **Robert C. Faris;** assistant secretary of Culver Aircraft, have been elected directors.

**I. H. Anderson** has been named district manager of sales for the Steel & Tubes Div., Republic Steel Corp.

**Judd W. Moody** is new eastern sales-engineering representative for Bendix Aviation, Ltd.

**Howard G. Dost,** chief armament inspector in Brewster's flight test department, combines business with his hobby. He has a collection of firearms which includes more than 150 unusual and invaluable pieces.

Consolidated Vultee announces the following appointments: **George Gerhauser** becomes assistant chief tool engineer, with **W. M. Hibbenhorst** succeeding him as superintendent of tool manufacturing. And **R. P. Waite** is new staff assistant to **I. W. Taylor,** chief of manufacturing facilities and standards.

**Leslie L. Espelin** is now director of engineering for Romec Pump.

**Helge G. Hoglund,** sales manager of the machine tool division of Van Norman Machine for the past ten years, has been named vice-president.

**Kenneth C. G. Gordon,** former assistant manager of the technical department of the Aeronautical Chamber, has joined the engineering staff of Fleetwings as a project engineer.

**John C. Leslie,** division manager of Pan American, has been elected to the Council of the Institute of Aeronautical Sciences.

**Robert C. Simpson,** former radio director, joins Higgins Aircraft, Inc., as assistant to the vice-president. Among other duties, he will handle public relations and publicity matters.

**Capt. William Nelson** has been

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named acting division manager for the new Consolidated Aircraft plant. **L. O. Cederwall** is chief project engineer. And **R. M. Zerbe,** engineer in charge of training and selective service at San Diego, becomes administrative engineer. **N. W. Bouley** and **Frank Haas** are assistant project engineers.

**Prof. William M. Smith,** head of the department of mathematics and registrar of Lafayette College, has been appointed director of studies of the Army preflight program at Lafayette.

**Charles P. Decker,** one of Douglas Aircraft's older employees, and **S. O. Porter,** director of personnel, comprise the "team" named as Douglas' "Team of the Month."

**E. I. Whyatt,** vice-president and treasurer of Northwest Airlines, has been named second vice-president of the Airline Finance & Accounting Conference of the ATA.

**Paul S. Baker** has been named engineering manager and **James M. Shoremaker** chief engineer at Chance Vought Aircraft.

**Robert Miller** has been elected executive vice-president and secretary of Menasco Mfg. Co.

Republic Aircraft announces the regrouping of its personnel division into separate staffs to be known as the Personnel Relations and Personnel Service Div. **Frank M. Hargreave,** personnel manager, will head the latter division, and **Fletcher D. Dodge,** chief interviewer, takes over the newly-created post as personnel relations manager.

**John T. Mascuch** has been unanimously re-elected president of Breeze Corp., and **Joseph F. Lucas** and **Fred G. Schupp** have been re-elected vice-president and treasurer, respectively. **Herbert J. Dwyer** was elected secretary. In addition, the following directors were named: **Frank C. Mindnich,** president of Federal Trust; **Clarence K. Pistell,** a director of Harvill Corp.; **Robert B. Reynolds,** president of Federal Laboratories, Inc.; and **David T. Wilentz,** Attorney General of the State of New Jersey, was elected chairman of the Board.

**Anthony W. Riccio,** president of the Gardenville Aeronautical Corp., is new test pilot at Republic Aircraft.

**William Loren Batt,** vice-chairman of WPB and president of S.K.F. Industries, has been honored with the Bok Award—a medal and a $10,000 check—not only for his service in leading industrial mobilization of the war but also as a citizen who performed the most distinguished service for Philadelphia in 1942.

**Clark H. Batchelder,** former "bronc-rider" and new personnel administrator for the flight and service department of Consolidated Aircraft, takes his Sunday relaxation by "emceeing" rodeos.

**Emerson Woodward** has been appointed to the newly created position of personnel coordinator for Northwest Airlines.

**A. F. Arcier,** Waco's chief engineer since 1930, has been appointed to the new office of vice-president in charge of engineering. He is also one of the two new directors added to the board. Other new board member is **R. E. Hoefflin,** again elected treasurer. Headed by **C. J. Brukner,** president, all other officers and directors were elected for another year.

**A. W. Herrington,** Marmon-Herrington board chairman, has been elected director of the Army Ordnance Assn.

**Donald M. Berges,** formerly chief field engineer for Eclipse Aviation, has moved to Cleveland to join Pump Engineering Service.

**Louis Wulfekuhler,** secretary of Lockheed Aircraft, has also been elected secretary of Vega; **Carl B. Squier,** another Lockheed v.-p. has been elected to the same position with Vega.

General Aircraft Corp. announces a reorganization of the management. Among other changes reported is the election of **Edward S. Gremse,** comptroller, as a director.

## Production-Battle Citations

Three stars, each indicating six months' continuation of the initial excellence which earned production recognition, now fly on the Army-Navy "E" pennant of

KEUFFEL & ESSER CO.

Second stars have been presented to

THE ELECTRIC STORAGE BATTERY CO.
LODGE & SHIPLEY MACHINE TOOL CO.
KROPP FORGE CO.

More manufacturers receiving first stars are

HARNISCHFEGER CORP.
SPERRY GYROSCOPE CO. (all plants)
WESTINGHOUSE ELECTRIC & MFG. CO. (eight plants)

"E" pennants have been won by

ALLIS-CHALMERS MFG. CO. (Supercharger, West Allis, and Electric Control plants)
AMERICAN FOUNDRY EQUIPMENT CO.
AMERICAN GEAR & MFG. CO.
AMERICAN HYDRAULICS
AMERICAN SCREW MACHINE PRODUCTS
CLARK EQUIPMENT CO. (Tructractor Div.)
CLAROSTAT MFG. CO.
DOUGLAS AIRCRAFT
FOOTE BROS. GEAR & MACHINE CORP.
GENERAL ELECTRIC CO. (Bridgeport Works)
B. F. GOODRICH CO. (Clarksville Div.)
HAMILTON STANDARD PROPELLERS DIV., United Aircraft Corp.
INGRAM-RICHARDSON MFG. CO.
LEEDS & NORTHRUP CO.
LIFESAVERS CORP.
LUCAS MACHINE TOOL CO.
REEVES BROS., INC. (three plants)
STANLEY TOOLS and STANLEY ELECTRIC TOOLS
THOMAS & BETTS CO.
THE WEATHERHEAD CO.
WHITING CORP.

# IT'S SMOOTHER, SURER STOPS WITH THE NEW SCOTT "B-711" BRAKE PRESSURE UNIT

Patent Pending

There's a real feeling of confidence when your heels engage the pedals of the newly-developed Scott Brake Pressure Units. You ***know*** you come to a smooth, safe stop when and where you want to. That's because these new hydraulic pressure cylinders are positive in action—absolutely fluid-tight—assuring top efficiency from the brake system. Designed for use on light aircraft using the expander tube brakes, these units may be adapted to other braking systems. Readily installed, and located with pedals in conventional relationship to the rudder pedal. Scott B-711 Brake Pressure Units are simple in design, durably constructed, light in weight (only 21 ounces). Each unit is exactingly tested to assure dependable, long-term performance. Economically priced. Write for illustrated folder.

The illustrations below show the locating and simple method of installing the pressure unit in the brake system: (1) Installation on Piper J-3 with floorboards removed showing method of reinforcing and attachment to structural members of fuselage. (2) Close up of left-side pressure unit showing cable extension to front seat brake pedal and attaching clamps. (3) Convenient arrangement of pressure unit pedal, located for easy, positive operation.

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In SPARTAN School's Meteorology Department you get superior specialized training to equip you for a position as a skilled weather forecaster—training that assures your being of far greater value to your country when called to military service. U. S. Army Air Forces, the Civil Service and the Airlines are experiencing a critical shortage of weather forecasters. *A bright future is ahead for both men and women* who are trained and ready to take advantage of the great opportunities in the post-war aviation industry.

Meteorology training facilities at SPARTAN are the most modern obtainable. Students are taught from the viewpoint of direct application to the needs of the aviation industry. This specialized division of SPARTAN has received high praise from Air Corps, Civil Service and Airline meteorology department heads for the thoroughness of instruction, methods of training, wealth of modern equipment and quality of graduates produced. Next Semester in Weather Forecasting starts July 4th—other courses Aug. 3rd.

***Announcing*** **SPARTAN COLLEGE OF AERONAUTICAL ENGINEERING**

Recognized and accredited by the Oklahoma State Regents for Higher Education. Affiliated with the Oklahoma State System of Higher Education. Intensified war-time scheduling enables students to earn 133 hours in 16 months. Graduates receive Associate in Arts Degree in Aeronautical Engineering.

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- ☐ Aircraft Sheet Metal
- ☐ Aircraft Assembly Mechanic
- ☐ Commercial Pilot
- ☐ Airline Service (A&E) Mechanic
- ☐ Airline Communications
- ☐ Private Pilot Course
- ☐ Weather Forecasting
- ☐ Instrument Technician
- ☐ Women's Instrument Technician

## West Coast Production Council Distributes Summary of First Year's Accomplishments

What cooperation has done to increase production is summarized in a bulletin, *Warplane Production*, just distributed among 5,000 manufacturers by the West Coast Aircraft War Production Council, Inc. Pooling of information, it is announced, increased weight of deliverics by member companies 295 percent between Nov. 30, 1941, and Feb. 28, 1943. "This figure," says the council, "reflects not only an over-all production increase, but also an intensified concentration on the heavier types of planes. It means that for every ton of fighting plane which the companies were delivering before Pearl Harbor they are now delivering four tons."

Increased efficiency is reflected in the facts that production increased more rapidly than costs and man-hours, which went up 210 and 53 percent, respectively. "Each man-hour," the council calculates, "now yields 2½ times the completed airplane poundage it was producing before the United States entered the war."

Output was stimulated through the exchange of 2,205 technical engineering reports, normally guarded trade secrets, and 20,022 emergency exchanges of production items, and general information was disseminated through a monthly bulletin and a special exchange division. Assistance was offered in the administration of the Controlled Materials Plan and absenteeism reduced to an average of 6.2 percent during January (AVIATION, April, p. 114 and 116). During March one member plant reduced absences to 3.3 percent, a peacetime rate.

## New SAWE Meeting Date

Date of the annual conference of the Society of Aeronautical Weight Engineers has been changed from May 3-5 to May 17-19. Headquarters will be the Adolphus Hotel, Dallas, Tex. Inquiries should be addressed to Dr. Howard W. Barlow, Dept. of Aeronautical Engineering, A & M College of Texas, College Station, Tex.

## WLB Forms West Coast Wage-Job Committee

Wage problems and job classifications in eight major Southern California aircraft plants will be referred to a War Labor Board committee named recently by Thomas F. Neblett, chairman of the Regional War Labor Board, San Francisco, who will serve as acting chairman.

To be empowered with broad authority in administering pay scales and work classifications established by the WLB directive of March 3, the group includes:

Industry—M. E. Beaman, industrial relations director, North American Aviation, and Graham L. Sterling, Jr., who holds a similar position at Northrop.

Labor—Roy M. Brown, vice-president AFL International Association of Machinists, South Gate, Calif., and William H. Brodie, CIO UAW, Los Angeles.

Alternates are: Industry—L. R. Becht, Consolidated; W. G. Tuttle, Vultee; Martin Porter, Lockheed; A. N. Rochlen, Douglas. Labor—Thomas McNett, IAM; Edward Hertz, AA and AIW of America; and Donald T. Ketchum, NU of UAW of America.

## Prizes Cut Absenteeism At Consolidated Vultee

Two Consolidated Vultee experiments aimed at solving personnel problems are progres ng satisfactorily, according to Pres. Harry Woodhead. One is designed to reduce absenteeism and the other to increase personnel by employment of part-time workers.

Cash prizes totaling $10,000 were awarded in drawings restricted to workers with perfect attendance records during the first four weeks of a new "Work-to-Win" program. Man-hours saved by regular attendance during that period were reported sufficient to produce six and one-half *Liberators*. Under the program, all workers having perfect time cards are eligible to share in the awards. Prizes total $10,000 monthly with an additional $5,000 to be distributed quarterly. The monthly awards include two of $1,000, four of $500, 20 of $100, 40 of $50, and 80 of $25.

Under the second experiment a four-hour six-day shift has been created to give additional employment to qualified persons whose occupations will permit an additional daily stint. Initial personnel of the new shift was drawn from professional, business and political ranks of San Diego. They were assigned to buck rivets, operate presses, drive lift trucks, and assemble parts from 7 to 11 p.m.

## Plant Inspectors Wanted

The Civil Service Commission has sent out an urgent call for aircraft factory inspectors. Applicants should be holders of aircraft mechanics and aircraft engine mechanics certificates with two years' supervisory or three years' inspection experience in aircraft manufacture or repair. Persons with CAA ratings of any kind are encouraged to file applications with the commission's Washington office. Pay is $3,828 a year, overtime compensation included.

## North American Converts P-51 into Army Bomber

Less than 200 lb. of extra equipment were required to convert the P-51 into this low-level Army bomber known as the A-36. Speed is announced as better than 400 mph., ceiling 30,000 ft.

At the request of the AAF, North American has been producing its P-51 *Mustang* in a fighting dive bomber model that can descend at 450 mph. with its four hydraulic dive brakes, one above and below each wing, extended.

Following their trial by the British, who took delivery on large numbers of them early in the war, P-51's were later ordered in quantity by our Army. Whether the air forces have placed continuing orders for the converted model, known as the A-36, is not known. Those already delivered are just going into action, so no performance reports are available.

The A-36, designed for combat, low-level ground attacks, and dive bombing, resembles the P-51 except for the hydraulic diving flaps and wing racks for bombs or auxiliary gas tanks. It will carry one ton of bombs or ammunition, but the Army does not say how far or exactly how fast. Announced straight - away speed is in excess of 400 mph. and ceiling 30,000 ft. Rate of climb is given as over half-a-mile a minute. Two 50-cal. machine guns in the nose fire through the three-blade propeller, and two more are mounted in each of the wings. North American is adapting the P-51 for *Merlin* engines, but all A-36's delivered so far have been equipped with 12-cyl. Allisons.

## Navy Orders More PBY's

A new order totaling more than $30,000,000 for PBY *Catalina* flying boats has been received from the Navy by Consolidated Vultee. This order is in addition to previously contracted deliveries now being made. In addition to carrying bombs and torpedoes, the *Catalina* has armament of 50-cal. machine guns and a range of 3,000 mi. Powered by two 1200-hp. engines, it is nearly 64 ft. long and has a wing span of 104 ft.

## New Consolidated Vultee Bomber To Surpass "Liberator" in Speed, Load

Fort Worth (Special to AVIATION)—Consolidated Vultee Aircraft has plans under way for near-future production here of a new four-engine, long-range heavy bomber designed to carry heavier loads greater distances and at higher speeds than the company's present B-24 *Liberators*, Harry Woodhead, president, has told members of the foremen's club of the Fort Worth division.

Woodhead d clared that the company's plants here and at San Diego were producing 70 percent of the *Liberator* and *Liberator Express* planes now being built by Consolidated Vultee and three other companies. "We all sincerely hope," he said, "that while this corporation continues to make more and more planes, next year our proportion of the total will not be so high, for that will mean that other companies making *Liberators* are well into production. And the more *Liberators* we and others produce, the sooner this war will be over."

Discussing production efficiency, Woodhead pointed out that due to the reduction in man-hours needed to build B-24's, it seemed safe to say that the company was now "delivering four-engine bombers to the Army and Navy at the world's lowest price for this type of aircraft." Efficiency at the San Diego plant, he said, has increased 250 percent, and on the PBY *Catalina*, "a plane which has been in production for several years and therefore supposedly a routine fabrication job, we have become 100 percent more efficient. In the past few months, he added, we have increased efficiency in producing the *Coronado* fully 100 percent.

## Structural Engineers Organize Society

The Society of Aircraft Structural Engineers has been formed in Wichita, Kan., by engineers of Beech, Boeing, and Cessna. Object is "the promotion of recognition of structural analysis and design as a special branch of aeronautical engineering, the exchange of design information, the recommendation of design criteria to licensing and procurement agencies, establishment of standard testing methods, and recommendation of problems requiring additional investigation."

At the first technical meeting, the membership of approximately 40 engineers heard A. G. Arundale of Boeing, their junior vice-president, read a paper on the problems and applications of electric strain gages. Topics were suggested to the technical committee for assignment to members for study.

## Plywood Group Organized

Formation of the Plastic-Plywood Aircraft Council, Inc., a non-profit organization with headquarters at 403 W. 8th St., Los Angeles is announced by its president Wendell S. Fletcher, of Fletcher Aviation Corp. Wesley G Palmer, formerly general manager of Morrow Aircraft Corp., will devote full time as general manager. Milton L. Gillespie of Gillcraft is secretary-treasurer.

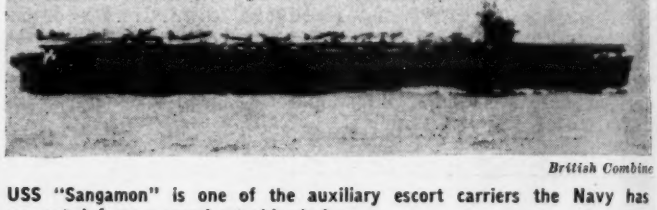
Stated objects of the Council are to disseminate manufacturing and processing information, serve as an engineering office to investigate and determine the value of production methods, and to present a united front in the government's metal substitute conversion program. Technical information will be distributed to members in an effort to economize on costs and speed up production of wood aircraft parts.

## New Carriers Described; Kaiser Flat-Top Launched

After successful trials, the U. S. S. *Breton*, a new offensive, escort carrier has been put in service. Built on the West Coast by the Seattle-Tacoma Shipbuilding Corp., which has been launching escort vessels, the *Breton* has latest types of defensive weapons, including equipment for protection against mines. She uses both steam and diesel power and can carry more than 1,000 men. Exact plane and crew capacity is secret.

Meanwhile, Washington intimated that the first of a new class of cruiser-carriers, converted from cruisers already on the ways, was about to go into service. And Vice-Adm. Frederick J. Horne, vice-chief of naval operations, revealed that another type of escort carrier was also being "built in dozens." These vessels were originally designed as merchant ships or naval auxiliaries and have catapults for launching planes in heavy weather. They have also served as ferry craft, transporting military planes to within flying distance of foreign bases.

First carrier built by Henry Kaiser, the *Alazon Bay*, has been launched in Vancouver, Wash., with the builder's prediction that he can launch three to six similar ships every month provided there are enough materials. Outside of the fact that the Kaiser carrier is 487 ft. on the water line and has a flight deck of 514 ft., no data on its speed, plane capacity, or other specifications were released.



British Combine

USS "Sangamon" is one of the auxiliary escort carriers the Navy has converted from a merchant ship design.

## Engineering Service

A free engineering and laboratory service providing precise readings on flatness and profile of mechanical parts is being offered manufacturers who do not have measuring equipment by Mid-West Abrasive Co., 1960 E. Milwaukee Ave., Detroit. "The service," the company announces, "includes return of the part along with readings and complete technical data on the grain, grade, tool speed, coolant, and pressure recommended to produce the required finish."

## Beaverbrook Hails Packard Production

In a recent speech before Parliament, Lord Beaverbrook was reported by the *London Daily Express* as remarking that "the best production job he had ever seen was done when the Packard Motor Car Co. produced our Rolls-Royce engine. In no time at all, production had been got under way," he was quoted as saying, "and the output is remarkable."

## Re-Modification Centers

About 30 modification centers throughout the country are making changes in most combat planes coming off the assembly lines, Pres. Roosevelt has told a press conference. The modification orders come

Members of new Society of Aircraft Structural Engineers, Wichita, Kan., in meeting. Seated, left to right, are Senior Vice-Pres. J. H. Gerteis, Cessna; Treas. Emmet Utter, Beech; Pres. W. R. Blakely, Beech; Junior Vice-Pres. A. G. Arundale, Boeing; and Sec. W. L. Gray, Boeing.

through every few weeks on all types of planes, the President said, and the average time for changes is about 30 days per plane.

### Ward Heads AWPC East

Word at presstime announces election of J. Carlton Ward, Jr., president of Fairchild Engine and Aircraft Corp., as president of the East Coast Aircraft War Production Council. Succeeding Glenn L. Martin, president of the newly-organized national council, Mr. Ward began serving the regular four-month term May 1.

Lawrence D. Bell, president of Bell Aircraft, has been chosen to serve a similar term as vice-president of the East Coast Council. Both he and Mr. Ward were named directors of the new national council at its organization meeting in Los Angeles.

## Assembly Lines

**Uniform standards** for the substitution of materials in aircraft are being developed by Army, Navy, and War Production Board, under direction of WPB's Aircraft Production Board. As a result of tests, standards have been established for conservation of methyl methacrylate and of beryllium-copper alloy for use in emergency steels; the substitution of zinc for cadmium; specifications for aluminum alloy products; alternative materials for corrosion-resisting steel cable terminals (for swaging); the use of aircraft plywood, and use of zinc for dies.

**Aircraft grade veneer**—manufactured from domestic sweet gum, water, tupelo, and yellow poplar logs—is one of the most vital materials in the production of warplanes and has now been brought under separate regulation by OPA with specific dollars and cents ceilings. The action will generally reduce the highest levels of current prices about 20 percent for material meeting Army-Navy specifications.

**Absenteeism** among factory and office workers at Ryan has dropped sharply in the last two months. Gains of as much as 32 percent in average attendance have been reported since January. The chief reason given for the improvement is an attack on unautnorized absences made by the employees' magazine. It published a chart showing that attendance at the factory was much higher on paydays than other days and lowest of all on Saturdays and Mondays. Biting labels and drawings accompanying the chart dramatized the cumulative effect of individual absences.

**Production** of tiny commutators for dynamotors supplying power for radio equipment has been stepped up 20 percent and cost cut 10 percent by an inspection device developed by Westinghouse and installed in its Mansfield, Ohio, plant. A light bulb, two mirrors, and four magnifying lenses reflect an enlarged image of the commutator on a glass screen so that the operator can determine whether copper and mica strips match desired lines on the screen. Relieving inspectors' eyestrain, the apparatus has cut the number of rejected parts from 30 to less than 3 percent.

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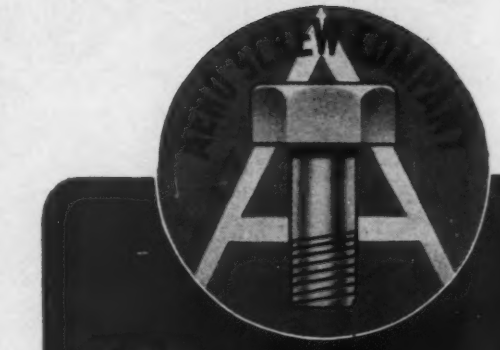

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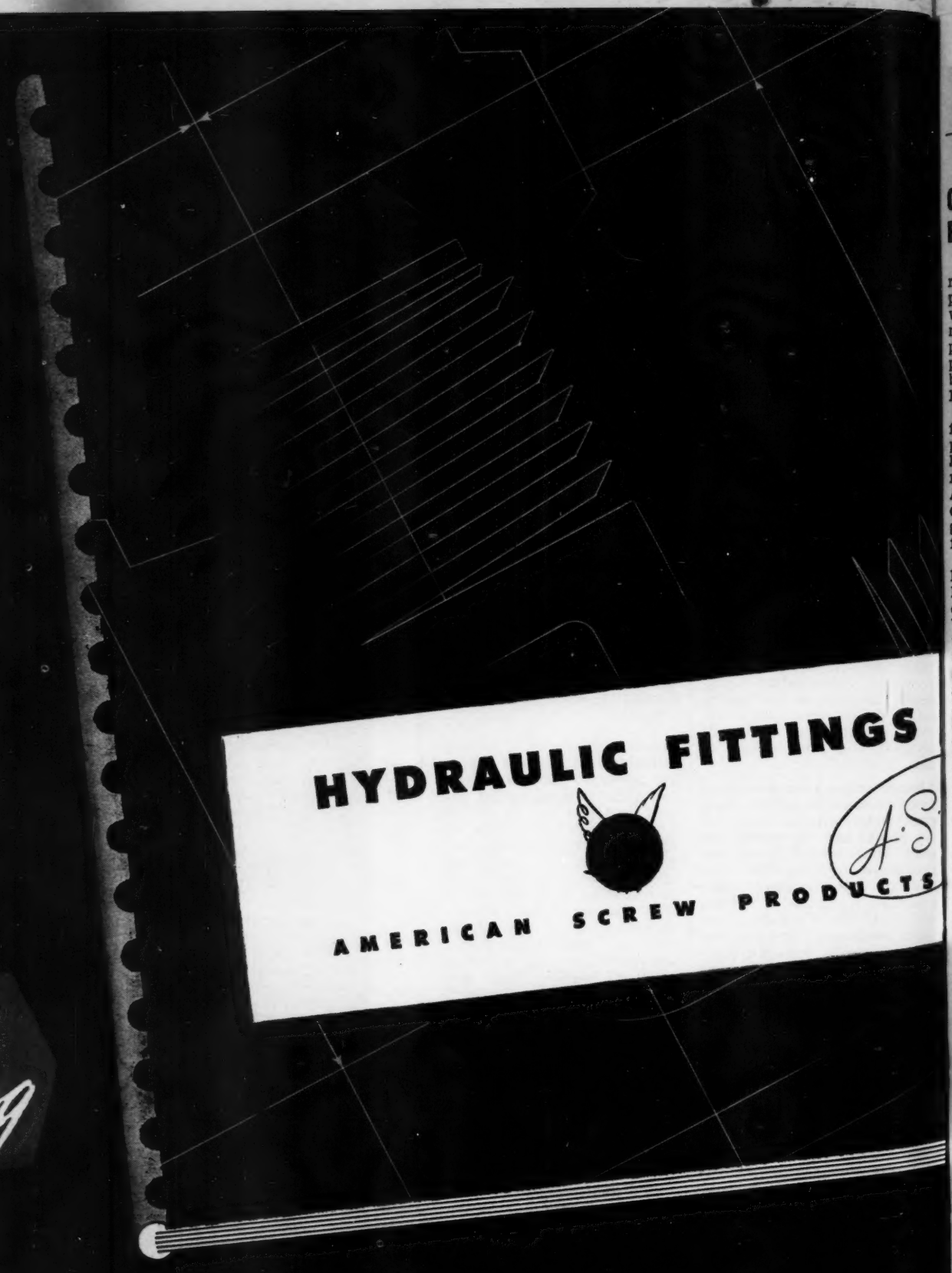


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## CAB Plans Hearing on 38 Applications For Postwar Air Mail Pickup Systems

Washington (AVIATION Bureau)—An investigation of the possibilities and problems involved in a nationwide air mail pickup system contemplated for development when peace comes has been ordered by the Civil Aeronautics Board.

CAB has 38 applications on file for certificates to operate pick-up organizations and has been giving attention to the matter for more than a year. A hearing for operators, plane designers, manufacturers, and government officials is planned for an early date.

The mail pickup technique has been thoroughly tested by Richard du Pont's All American Aviation, centering at Wilmington, and serving 115 towns in six states. This system was started several years ago as an experiment under a separate contract with the Post Office Department. When its success was apparent, the system was certificated by CAB. Another Post Office experiment of the time was an autogiro operation from the roof of the Philadelphia post office to the airport.

The pickup program contemplated by the board is intended to give the nation a new kind of mail service, approved by everybody, to employ some of the thousands of pilots who will return from the war, and to create a market for a portion of the nation's expanded airplane plant.

It ties in, too, with both the air cargo and all-mail-over-night programs, which are expected to get under way immediately after the war. Also involved are the promising possibilities of the direct lift machines. Igor Sikorsky says that helicopters now in prospect will carry 20 passengers on short-range operations.

CAB officials say they believe designers will suggest special low-cost, high-lift airplanes for the pickup system, similar in some respects to the Stinson "A" of a decade ago. This tri-engine plane was built for short-range service, about 650 miles. Its speed was 150 miles. Its throttles 60 percent open. The engines developed 240 hp. each. It is now expected, however, that new designs will have twin- or single-engines, not three. New rulings may be necessary if passengers are to be carried in single-engine planes on scheduled flights.

Mr. du Pont studied the question of carrying passengers on mail pickup planes two or three years ago but came to no decision. It was thought that passengers might object to the zooms and dives of the pickup operations. This matter will come up again. Also the question of safety will be reconsidered, but some observers contend that there is less risk in a pickup than there is in a landing and takeoff. The du Pont system has had no serious accidents and reports completion of nearly 150,000 pickups and deliveries in 2,500,000 flying miles.

A fully developed pickup system, covering all the populous areas of the country, would total more miles and employ more people and planes than present air trunklines.

### Air Mail Celebration

Twenty-fifth anniversary of the inauguration of regular air mail service in the United States will be observed nationally and will culminate in a program at the Washington National Airport on Sunday, May 16.

Air mail service actually started May 15, 1918, between Washington and New York, but Sunday the 16th has been chosen for the Capital's celebration to avoid interference with war work.

### ATC Losses Fractional

Losses of planes en route by the Air Transport Command amounted to only .04 percent during February, the busiest plane delivery month on record, according to Maj. Gen. Harold L. George, chief of ATC. No planes have been lost from enemy action on the Pacific ferry route, the general said in calling the worldwide accomplishments of the service "something no one would believe unless he'd been reading Jules Verne."

### Western Reduces Rates

A 10 percent reduction in passenger fares was announced April 1 on Western Air Lines by its president, William A. Coulter. The new rates, effective immediately upon approval by the Civil Aeronautics Board, will be applicable only between points on the California-to-Canada system. Western observed its 17th anniversary on April 17, and Pres. Coulter recalled that during its first year of operation the line carried 209 passengers, 71,414 lb. of mail, and 263 lb. of express. Today's figures are military secrets, but they are said to be the greatest in the company's history, including military cargoes delivered to an undisclosed war front.

### PCA Anniversary

Sixteenth anniversary of Pennsylvania-Central Airlines was observed April 26 at the Carlton Hotel, Washington, by a dinner given by the National Aeronautic Assn. PCA, which started with a 127-mi. route between Pittsburgh and Cleveland in 1927, now has headquarters in Washington, employs 2,000 people and, in 1941, operated 65,549,526 revenue passenger miles among 40 cities in twelve states, concentrating on its established "shorthaul policy."

Among the company's officers are C. Bedell Monro, president; Frederick R. Crawford, secretary and executive vice-president; and James H. Carmichael, J. J. O'Donovan, Luther Harris, and R. J. Wilson, vice presidents.

## CAB Unlikely to Act Upon Foreign Route Applications

S. J. Solomon, president of Northeast Airlines, points out a proposed foreign route to H. Anderson, vice-president and chief operating officer, and Robert S. Swain, vice-president and treasurer. Northeast has also filed an application with CAB to operate a helicopter mail service among some 400 New England towns.

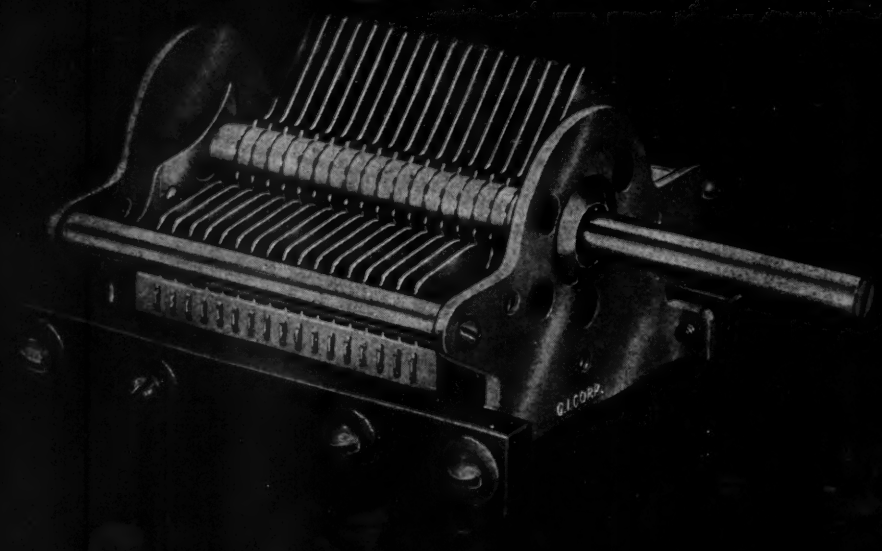
Washington (AVIATION Bureau)—Northeast Airlines has surprised the transport industry by filing an application with CAB for a certificate to operate between Boston and Moscow, London, Paris, Amsterdam, and other European cities.

All of the domestic lines, under contract with the Army Air Transport Command, have thought about applications for certificates to continue peacetime operations on their wartime routes, but they hadn't intended to file them yet. Northeast's action was followed immediately by a request from Northwest Airlines for a route via Alaska to Calcutta. CAB expects other operators to file any time.

Sources informed on board policy say it is unlikely that any early action will be taken on such applications. The Administration has not yet formulated its foreign air policy, which must be integrated with whatever world policy is adopted at the peace table. Also, CAB is watching the operations of the Transport Command as an indication as to where any new routes should lead.

Even if the board approved

# Con cat'e nate*



## * To link together, unite in a series or chain

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foreign service applications now, and if the Army and Navy did likewise, there would still be the question of entry into the terminal countries. Extensive negotiations would be necessary with Russia, Norway, and Sweden in the case of the route to Moscow. Norway is in no position to negotiate, and the other two probably would not be disposed to. In the case of the Northwest proposal, the Japs currently stand between here and Calcutta.

One thing only seems clear: There is going to be a free-for-all scrimmage, old rugby style, for places in the sun. Trans-Canada chimes in with announcement of its intention to set up transocean routes, apparently to both Europe and Asia. United has indicated leanings toward South America by getting an option on a Mexican line from the United States border to Mexico City. Nearly all airline companies have ambitious postwar plans.

## Certificate Given PAA For U. S.-Guatemala Route

Pan American Airways has been granted a three-year temporary certificate by CAB to operate a new service between New Orleans and Guatemala City, connecting with its network of Latin American routes.

This temporary authorization to PAA leaves the way open, not only to American Export Airlines, whose application for the New Orleans route was denied, but to any other operators to make application to compete with PAA in this region. Export's request for a New Orleans-Central America run was rejected for lack of equipment to start at once and because the entire route would be a pioneering job for the company. Export is letting the matter rest for the present.

The 1,075-mi. flight across the Gulf of Mexico will be made in six hours, according to a PAA announcement. Boeing *Stratoliners* with accommodations for 33 passengers in pressurized cabins for high-altitude flying will be used. Negotiations are underway with Mexico for an additional stop at Merida on the Yucatan Peninsula. It is said that a trip from Chicago to the Canal Zone will be made in approximately 21 hr.

On the West Coast, PAA has made plans to move its Los Angeles base from Grand Central Air Terminal, in Glendale, Calif., to Lockheed Air Terminal, Burbank, on or about June 1, according to S. E. Judd, local operations manager. A new terminal building, which will contain passenger lounges, ticket counters, operations offices, communications, reservations, and traffic offices, and quarters for U. S. Customs, Immigration, Health, and Agriculture departments, is under construction. It will be used also by the system's subsidiary company, Cia., Mexicana de Aviacion, which operates a daily schedule between Los Angeles and Mexico City with stops at Mexicali, Hermosillo, Mazatlan, and Guadalajara.

## Feeder Routes Requested By Western Air Lines

Application for approval of feeder routes reaching 81 cities in eight states in a 5,955-mi. network has been filed with the CAB by Western Air Lines, according to Leo Dwerlkotte, executive vice-president. The network is designed to tie-in all important centers adjacent to the present system of the line, which extends from San Diego through Los Angeles and Salt Lake City to Lethbridge, Alberta.

As now planned, the system will be divided into nine separate units: Montana Eastern, Montana Western, Idaho, Utah Eastern, Utah Western, Nevada, Arizona, California Southern, and California Northern. Typical of all of the units is the Montana Eastern which will have feeders and pick-up lines reaching Great Fall, Helena, Butte, Dillon, Bozeman, Livingston, Billings, Miles City, Glendive, Sidney, Glasgow, Havre, and Lewiston.

Service will be started as soon as the board can devote its energy to peacetime aviation development, Mr. Dwerlkotte said.

## FDR Approves Colonial Extension to Charleston

Washington (AVIATION Bureau)—Extension of the Montreal - New York route of Colonial Airways (formerly Canadian Colonial) to Charleston, S. C., has been approved by Pres. Roosevelt as a "war service." The company, American-owned, has had this project before CAB since 1940, but competing lines have managed to delay action on the application. After hearing pleas of seven eastern seaboard congressmen, Mr. Roosevelt certified the route, which will serve an area congested with Army camps, Navy and Marine bases, and shipyards, with the reservation that he "was not in favor at this time of establishing any new permanent air routes for the postwar world." CAB will be asked to reconsider his approval on the basis of wartime transportation needs.

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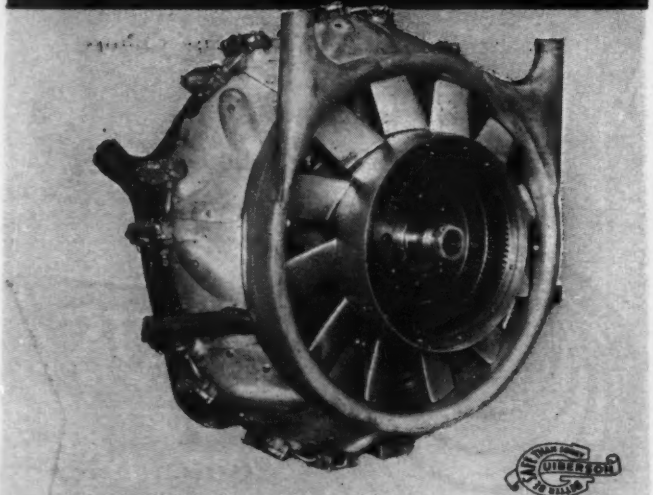


# Aviation Abroad

## International Routes Being "Considered" By Trans-Canada; Report for 1942 Issued

Toronto (Special to AVIATION) — Trans-Canada Airlines, publicly owned transcontinental transport company, "is giving consideration to plans for oceanic and international flying," according to its annual for 1942, tabled in the House of Commons at Ottawa. A few days later Prime Minister Mackenzie King stated in Parliament that "the government sees no good reason for changing its policy that Trans-Canada Airlines is the sole Canadian agency which may operate international air services." Thus official policy is that intercity and international air transport by Canadian companies shall be under public ownership.

"Within Canada," Mr. King added, "TCA will continue to operate all transcontinental systems and such other services of a mainline character as may from time to time be designated by the government. Competition between air services over the same route will not be permitted whether between a publicly owned service and a privately owned service, or between two privately owned services.

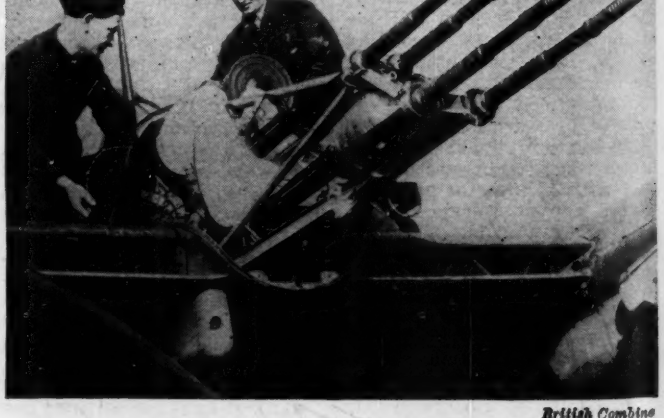
"The Canadian government strongly favors a policy of international collaboration and cooperation in air transport and is prepared to support in international negotiations whatever international air transport policy can be demonstrated as being best calculated to serve not only the immediate national interests of Canada but also our overriding interests in the establishment of an international order which will prevent the outbreak of another World War. The government intends to plan a number of routes suitable for postwar air services and offering traffic possibilities that will warrant a service."

The Prime Minister said that these postwar routes will use airfields developed for war purposes, and that the government will continue to develop airports and further facilities for communications and weather reporting.

In TCA's report, Pres. H. J. Symington predicts that "Canada's national airline is destined to play an important part in world aviation. The shortest routes between North America and Europe and Asia cross Canada, and weather conditions are stable. But formulation of detailed programs must await developments."

Three TCA flight crews were assigned in 1942 to supplement the trans-Atlantic flight organizations of British Overseas Airways with the cooperation of the RCAF and TCA supervisory personnel. At Montreal airport TCA maintenance and overhaul crews, numbering upward of 200 mechanics, service British Overseas transports.

TCA plans a service to the



British Combine

**"WHIRLWIND" DOES SOME REAPING**

Hispano 20-mm. cannon are loaded on one of Britain's twin-engine "Whirlwind" fighter-bombers, which are carrying on day and night attacks against enemy coastal shipping. They have destroyed many key installations and railway trains in occupied territory during the past six months. New Zealanders are among "Whirlwind" squadron pilots.

Yukon and Alaska, but due to Alaska's being declared a military zone by the United States, this extension has been delayed. Canadian Pacific Airlines, privately owned by Canadian Pacific Railways, now operates to Whitehorse, Mayo, and Dawson in the Yukon.

The company is shortening its transcontinental route by flying from Toronto via Sault Ste. Marie to Winnipeg, crossing Lakes Huron and Superior, instead of the present overland route from Toronto via North Bay, Kapuskasing, and Armstrong to Winnipeg. Other new routes planned include Montreal, Ottawa, North Bay to Sault Ste. Marie, and thence Winnipeg; Winnipeg direct to Edmonton via Saskatoon; and Vancouver to Vancouver Island and the city of Victoria.

Indicative of expansion, the annual report shows passenger revenue up 23 percent, mail 66 percent, and air express 100 percent in 1942. Operating revenue increased from $1,529,524 to $7,337,318 and operating expenses from $1,322,253 to $6,628,399. After allowing for income charges and interest, surplus was $494,915 compared to $302,436 in 1941. The company had 24 Lockheed airplanes in operation at end of 1942, and total personnel of 1,662, of whom 464 were women.

Changes in key traffic posts have also been announced by TCA. J. J. Robinson, traffic representative at Toronto, has become city traffic manager at Vancouver; S. L. Blowes, traffic representative at Toronto, has been transferred to Windsor, Ont.; H. D. Harling, city traffic manager at Toronto, is in the Winnipeg office as district traffic manager; W. G. Courtney, city traffic manager at Vancouver, and R. E. Deyman, city traffic manager, Windsor, have been moved to Toronto as district and assistant district managers respectively.

## Mexican Line Option Acquired by UALTC

Through a $250,000 loan, United Air Lines Transport Corp. has acquired an option in the controlling interest in Lineas Aereas Mineras of Mexico as a first step in a contemplated expansion of UAL operations in Mexico.

An application has also been filed by United with CAB for purchase of 75 percent of the capital stock of Lineas Aereas Mineras S. A. If it is approved, United will begin immediate plant improvements in Mexico City.

"While ultimately it may be possible to establish an airline from LAMSA's northwestern terminal at Nogales to United's West Coast route extending from San Diego to Vancouver, our present object is to assist the operators to obtain improved flight and ground equipment," said W. A. Patterson, president of UAL. "It is United's intention to leave the operating management of LAMSA in the hands of those people who developed it and to expand the company around its own leaders."

## 25th RAF Anniversary Hailed by United Nations

Marking the 25th anniversary of the Royal Air Force, April 1 was, rightly a red letter day celebrated in England and an occasion lauded by the United Nations. And again the day saw the RAF's warplanes attacking over Germany just as on April 1, 1918, the day of the service's birth in World War I.

Born in a still-earlier April —the April of 1912—Britain's initial flying services first developed as the RFC (Royal Flying Corps) and the RNAS (Royal Navy Air Service). Combination of the two formed the present service six years later, and it is notable that many present RAF leaders were "charter members." For instance, the man who signed-in back in '18 as "C. F. Portal, Lt., R.E. (Royal Engineers), attached RFC," is now Air Chief Marshal Sir Charles Portal, chief of the British Air Staff.

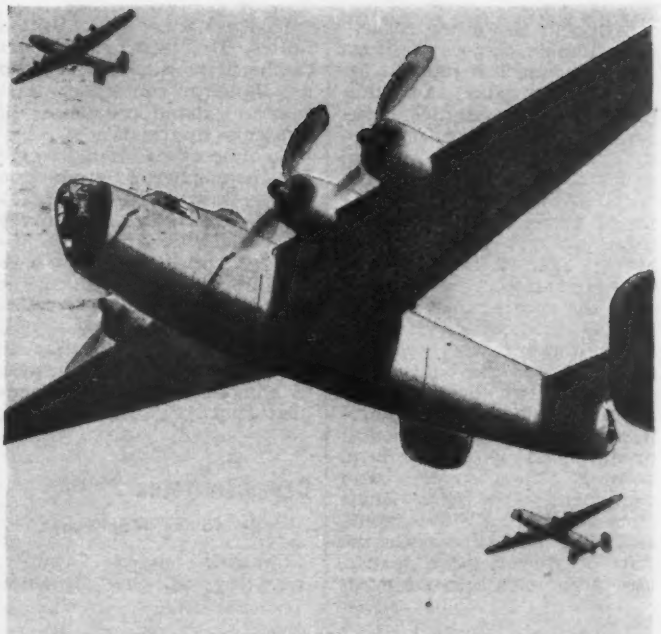
The RAF of today has attained new peaks of power, daily adding to its formidable record. However, no account of its performances is complete without a prior salute to its striking curb of the Nazi air thrusts aimed to defeat England in 1940. This record speaks for itself.

Aug. 15, 1940: 181 German planes shot down . . . Aug. 18: 152 . . . and Sept. 15: 185. Calculations have it that, against a loss of 375 RAF pilots, 2,375 of Hitler's warplanes were destroyed between August 8 and October 31 of that year.

This was too much for the touted Luftwaffe to "take" in English skies. And since then the RAF has consolidated an offense which is proving too much for it today to "take" over Germany itself.

## Medical Transport Aids Hemisphere Defense

The fast growing network of inter-American airlines is playing a new wartime role as life saver for workers in the Western Hemisphere's battle for production and materials. Southbound planes from the United States are

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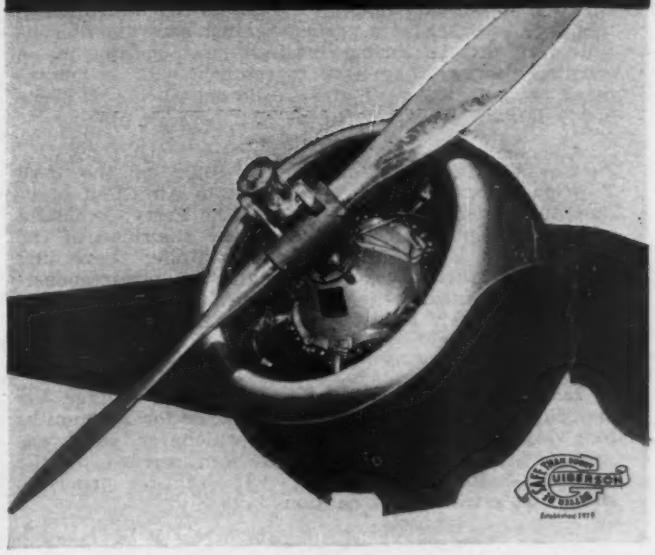

carrying to the other Americas valuable cargoes of drugs and other medical supplies for new health and sanitation programs. For instance, thousands of workers are now being moved into the Amazon valley to increase rubber production, while others are entering mines and forests. All these workers must be protected against malaria and the other tropical diseases.

In the race against time to provide medical services for these workers, the great air transport systems built up in the past two decades now serve the doctors and engineers engaged in the health program. Many of these men, with all their supplies and equipment, are flying south from the United States, while returning planes increase the flow of rubber, mica, quartz, and other strategic materials from these areas to the United States. This movement is part of the plans made at the Rio de Janeiro conference last year to expand production of strategic materials.

So important is flying to the hemisphere's production tasks, that extension of facilities continues in many places notwithstanding the industry's pre-occupation with military aircraft. The airline network in the other Americas is now two and a half times greater than that in the United States proper, with 45 companies and 750 scheduled stops.

## Canadian Notes

**By James Montagnes**

*Catalina* patrol bombers operating off the Canadian coasts are using a secret radio submarine-detecting device, it was recently disclosed by Ralph P. Bell, director-general of Canadian aircraft production. He also stated that the planes had a secret bombsight but did not indicate whether it was of American or Canadian design.

**Canada's aircraft** industry has orders for about $1,000,000,000 till mid-1944, according to a statement of the Wartime Information Board. Nine types of planes are now being manufactured by 83,000 workers.

**Now that censors** have released information on the North Quebec Shipsaw water power development for aluminum production, the story of the part played by air transport on this wartime project can be told. Personnel and planes of companies now part of Canadian Pacific Air Lines had a major role in building the mighty 1,000,000 hp. dam along the Saguenay River. The construction site and river systems far to the north of the power dam were photographed from the air. The building of storage dams more than 100 mi. to the north of the power site and inaccessible by rail brought about the biggest single air contract in Canadian history.

**Simplification** of physical examinations for air crews and greater elasticity in choosing men to fly in the RCAF were announced in Ottawa at the beginning of April by Group Capt. J. W. Tice, director of medical services. The new regulations follow a survey conducted by the medical services of the RCAF on whether there was any way of charting a man's chances of becoming a pilot before training had been started.

"The only general theory we developed was that the success of a youth in learning to fly was determined largely by how ardently he wanted to fly," Tice stated. "If his motivation was strong enough, he would learn."

The medical director revealed that a number of former physical regulations that might "wash out" a flying candidate, had been eliminated. Slight cases of hay fever no longer prevent a man from becoming a pilot, and the self-balancing, balancing rod, and the vital capacity tests have been eliminated.

**Noorduyn** Aircraft Corp., Montreal, reports that it is now delivering UC-64 utility cargo transport planes to the USAAF. This is a highwing monoplane, easily convertible to skis, wheels, or floats and is powered by a single 550-hp. engine. It is the only plane of Canadian design being sent to the United States Army.

**Aircraft workers** are now being given a badge for street wear to show that they are on the factory front. Round

in shape, it shows in the centerpiece a silver plane over a red maple leaf on a white field. The rim is blue and bears the words "Aircraft Production". To merit the badge the worker must have been on the job steadily for at least three months. Individual aircraft companies can add their name to the wording on the rim.

## ★ ★ INTERNATIONAL BRIEFS ★ ★

An Army bomber has set a new long-distance record: 12,000 mi. to India in 67½ hr. . . . Mexican airline service to some smaller cities was recently curtailed because of temporary gasoline shortages. . . . The Chinese press is crying for more transports, arguing that 100 modern cargo carriers equal the capacity of the Burma Road.

A new Russian fighter, the *Lavochkin*, is in action, and its initial performance is reported satisfactory. . . . Peruvian military pilots recently ferried six Vultees from California south for use in their air force. . . . Following our example, Mexico has established two government-operated schools to be used for training commercial pilots.

Through Jose Ribeiro Dantas, company president, Cruzeiro Do Sul, Ltd., has purchased four Douglas transports replacing former German equipment. The 7,000-mi. Brazilian airline is successor to the old Nazi Lufthansa Condor lines. . . . Meanwhile several hundred Brazilian flyers are coming to the United States for military air training. Aviation impetus has given Brazil more than 500 airfields and a growing number of flying clubs. . . . H. H. Balfour, British Under-Secretary for Air, reports that Britain intends to employ helicopters to provide additional protection for shipping convoys.

## On Schedule . . . by "Vista"

**Following establishment** of the Royal Air Force Air Transport Command and announcement of British plans to occupy a powerful position in postwar commercial aviation, the virtually wholesale resignation of the board of British Overseas Airways Corp. was greeted with some astonishment. While it was officially announced that this was due to a breakdown of negotiations between the BOAC and the RAF Transport Command on the point of control of regular services, it is generally felt in informed circles that there is a much deeper reason for this sudden action.

**BOAC was originated** some years back under government pressure by the merger of Imperial Airways and British Airways. The intent was to consolidate and improve England's international airlines, which had lagged somewhat due to lack of modern equipment and planning. The British government always took a hand in running BOAC and kept it going by large subsidies and air mail payments. Recently the organization has suffered from lack of interest in official circles for its future and was seriously handicapped by the gradual reduction in its fleet. When this latter fact was made public and embarrassing questions started to fly, it was officially announced that new planes would become available and that proper arrangements for postwar expansion were being made. Evidently these arrangements consisted of the new RAF Transport Command, which would operate the new planes and indirectly exercise complete control over BOAC's activities. Action of the BOAC board must therefore be taken as a protest against government control over private airline interests and perhaps as a warning that we may have to compete with a government controlled, owned and subsidized airline in postwar aviation.

**Post as Air Officer** Commander in Chief of the RAF Transport Command has been given to Air Chief Marshal Sir Frederick Bowhill, head of the Ferry Command since its inception in 1941. A d new chairman of the BOAC board is Sir Harold Howitt. Under "governing agreements," the Transport Command will have responsibility for organizing the corporation's routes and facilities, and the Air Ministry will allot BOAC planes and decide its services.

**In Bermuda, BOAC was given authority** to manage the Darrell's Island Airport for two years or for six months following the end of the war, whichever time was shorter after the Assembly had been warned by the speaker, J. Reginald Conyers, that exclusive privileges should be granted with caution.

# Aviation Finance

By RAYMOND L. HOADLEY

AFTER HAVING CONCLUDED their most prosperous year in 1942, the domestic airlines have suffered several jolts this year. These include lower airmail pay and government pressure to reduce passenger rates. These developments may well cause a quite substantial cut in revenues. The latest sign pointing in that direction is the intimation by postal authorities that airmail may have to be barred completely to the general public, may be put on a priority system, or that private airmail be limited to a 500-mi. radius because of the over-burdening of mail planes.

Intimations of this sort generally precede definite action along the lines suggested in official circles. Thus, when and if airline priorities are invoked, the airlines can look forward to a sudden termination of the recent sharp increases in airmail volume.

Annual reports of the automotive industry, including the extended remarks to shareholders by company executives, may be read from cover to cover without gaining any inkling of the postwar plans of these concerns regarding aviation. Officials of some of the smaller motor car companies asserted privately, back in the earlier stages of the defense and war program, that they intended to "clear out" of the aircraft field when the war was over, but none of them have gone on record in print to that effect. Others have side stepped leading questions put to them at press conferences by saying that it was more likely that the aircraft companies would enter the automotive field.

As a matter of fact, there have been recurring rumors that prominent aircraft manufacturers are planning to enter the cheap motor car field, and the story goes, that some already have developed models for introduction to the public after the war. Other rumors tie in the plane makers with prefabricated housing for postwar days. So far, however, these "yarns" have not elicited any comment from aircraft industry officials. They are "sticking close to their knitting," whatever postwar plans they may be mulling over in spare moments.

Ernest R. Breech, president of Bendix Aviation, has pioneered in a new public relations concept for the aircraft industry—using paid advertising in some seventy newspapers to give the taxpayers, as present or prospective customers of the company, a breakdown of salient facts in the 1942 annual report. It is another indication that thinking in the aviation industry is broader in terms of public responsibility than just war production, all-important as that is at present.

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**In a decision** affecting all major domestic air transport companies, the Minnesota supreme court has rule that Northwest Airlines Inc. must pay personal property taxes and penalties totaling $18,261 for Ramsey County, Minn. The majority opinion held that the state has power to tax a whole fleet of airplanes "so long as no part of it is permanently located in another state."

**The Association of Casualty & Surety Executives**, representing sixty leading casualty insurance companies, have formed a permanent aviation advisory committee to handle insurance matters affecting aviation interests in recognition of the increasing use of aircraft and the growing demands for insurance coverage.

**General Electric's** aeronautical business is now "several thousand times what it has ever been previously," the company told its stockholders recently in a report accompanying quarterly dividend checks. Every one of the company's plants is now turning out aviation equipment of some type.

**Eastern Air Lines** reported net earnings for the nine months ended Sept. 30, 1942 of $2,050,316 or $3.57 a share compared with $883,169 or $1.54 for the like 1941 period. Northwest Airlines reported a net profit of $201,916 for the third quarter of 1942. Total operating revenues for the period were $1,226,152.

**North American Aviation's** earnings of $10,436,413 or $3.04 a share for the fiscal year ended Sept. 30, 1942, may be considerably changed by the renegotiation of contracts and the War Labor Board's decision regarding wage increases in West Coast airplane plants, J. H. Kindelberger, president, indicated in the annual report to stockholders. Figures regarding government contracts are before the price adjustment board of the Army Air Forces and the final agreement, he said, might alter the profit reported to stockholders. Similarly, if the WLB orders retroactive increases in labor rates, earnings might be affected.

**In spite** of an increase of 177 percent in sales, net profits of **Douglas Aircraft** in the 1942 fiscal year showed a reduction of 40 percent from the preceding year. Net profits were $11,054,620 or $18.42 a share against $18,176,690 or $30.29 a share in 1941. Sales jumped from $180,940,100 to $501,781,984 while the backlog of unfilled orders stood at more than $2,000,000,000 at the end of November. End of the war, according to Pres. Donald Douglas, will find the company in a strategic position, with 35 percent of its output which is now in cargo and troop-carrying planes readily convertible to commercial transports. Douglas had received $2,373,000,000 of United States contracts through last November, fourth largest total for any corporate unit in the nation.

**Lockheed Aircraft Corp.** reported 1942 earnings of $8,163,721 or $7.59 a share against $7,416,537 or $6.89 a share in 1941. Included in reserves was $3,500,000 for postwar adjustments and $2,000,000 as a reserve against obsolescence of inventories. Pres. Robert Gross reveals that the company had liquidated a bank debt of $42,500,000 in 1942, which had enabled it, under the refund provisions of the tax law, to reduce taxes by $5,651,517. Moreover, $5,000,000 had been set aside as a fund for contingency reserves, while a $3,500,000 reserve was established for postwar adjustments. Directors declared a 50c. dividend payable Mar. 29. This action is not an indication that regular quarterly dividends will be paid. Rather, it reflects the intention to pay smaller interim dividends from time to time when and if conditions justify. It has been the practice of the company in the past to make one payment a year.

**Pan American Airways** has, according to Wall Street reports, unofficially sounded out the possibilities of offering a stock participation to domestic airlines. The company has not commented on the rumors.

**Although commercial** operations of **American Airlines** were curtailed in 1942, other services and non-recurring profit from the sale of flight equipment ($834,845) enabled the line to report net earnings of $3,851,714 or $6.33 a share compared with $2,473,160 or $3.93 a share in 1941. Airmail revenues declined 23 percent, according to Pres. A. N. Kemp, and this was despite the larger amount of mail transported.

**General Motors Corp.** has attained the capacity for producing a $4,000,000,000 annual volume of business, according to the annual report showing net earnings of $163,651,587 or $3.55 a share compared with $201,652,508 or $4.44 a share in 1941. Postwar reserves aggregate $40,584,000.

**Abnormal wartime traffic** contributed to record net earnings of $3,134,356 or $2.08 a share for **United Air Lines** in 1942 compared with $598,050 or 40c. a share in 1941. Direct contract work for the Army produced a profit of only $115,[illegible]5 out of the year's total net. A reserve of $1,000,000 was set aside for postwar adjustments. In addition, UAL has loaned $250,000 to **Lineas Acreas Mineras,** a Mexican airline with an option to purchase 75 percent of that line's capital stock. If purchase of the stock is approved by the CAB, United plans to start construction of modern plant and maintenance facilities for the company at Mexico City. Eventually, United plans to extend its Pacific Coast operations by establishing a link from San Diego to Nogales, Mexico, northwestern terminal of LAM.

**Glenn L. Martin Co.** sales last year totalled $337,556,000 against $67,237,689 in 1941, a gain of around 500 percent. Net earnings were $6,658,809 or $6.01 a share against $5,773,148 or $5.24 a share in 1941. A reserve of $3,000,000 was set aside for contingencies. Commenting on the postwar outlook, Pres. Glenn L. Martin emphasized that cargo carrying planes will be of great national and international importance in the future, and he accordingly pointed to the company's long experience in designing and building large aircraft. The company, he added, is developing new devices, the application of which is not limited to the aircraft field. Substantial progress, he reports, has been made in that direction.

**Bell Aircraft Corp.** reports sales of $130,763,227 for 1942 compared with $46,414,444 in 1941. Earnings amounted to $4,203,583 or $11.78 a share against $1,970,645 in 1941. Pres. Lawrence D. Bell has told stockholders that the company's 1943 output of fighters and ordnance devices will greatly exceed that of 1942. He also referred to the new bomber plant in Georgia, which was occupied by the company on Apr. 15. Under Bell's recently negotiated bank loan agreement, the company cannot pay dividends in excess of 50 percent of net income since Dec. 31, 1942 and not more than $1,200,000 in any one year. Dividend payments last year aggregated $713,500, while the postwar contingency reserve totaled $1,200,000.

**Sales of the Square D Co.** last year were at a record level of $39,349,044, an increase of 43 percent over the $27,425,515 in 1941. All divisions contributed to the gain, but progress in the **Kollsman Instrument Div.** was outstanding, according to Pres. F. W. Magin.

**Sperry Corp.** had a backlog of orders of nearly $1,000,000,000 at the end of 1942, Pres. Thomas A. Morgan recently disclosed, while sales last year totaled nearly $250,000,000. Shipments equalled those of the nine previous years combined. Peak output, he said, will not be reached until several more plants are fully equipped and manned. Shipments this year should double those of 1942, while some $3,000,000,000 of Sperry-developed products are expected to be produced during the war.

**With sales** up 240 percent last year to a total of $47,080,224, against $13,802,437 in 1941, net profits of the **Fairchild Engine & Airplane Co.** rose 16 percent to $626,744 or 60c. a share from $541,079 or 52c. a share in 1941. Commenting on the outlook, Pres. J. Carlton Ward states that, based on current schedules, shipments will again materially increase in 1943. Total postwar reserves were $775,793 at the end of 1942. A $750,000 bank loan outstanding at the end of 1942 has since been repaid. Directors have considered dividend payments, but they have decided that working capital requirements precluded a distribution at this time.

**Eastern Air Lines** reported net earnings of $1,885,503 or $3.28 a share for 1942 against $1,609,706 or $2.81 a share in 1941. Should no excess profits tax liability for 1942 accrue, taxes would be reduced by $2,000,000 or around $3.47 a share. This tax matter had not yet been clarified when the financial report was published.

**Western Air Lines** stockholders have approved an increase in the authorized stock from 500,000 to 1,000,000 common shares. Pres. William A. Coulter reports that the action was taken "in order to be in readiness for the expansion of airline transportation and cargo activities which will develop immediately following the war, if not sooner."

**Thompson Products, Inc.,** set new high records in both sales and earnings last year, with profits amounting to $2,051,417 or $6.49 a share as compared with $1,722,689 or $5.56 a share in 1941. Sales totaled $85,946,028 in 1942, of which $26,025,233 came from the aircraft subsidiary (Tapco). During December, the report states, an $18,000,000 bank credit was negotiated for the purpose of retiring RFC loans and to provide additional working capital. Renegotiation of contract proceedings were still pending when the report was issued. Approximately $9,900,000 had been borrowed under the bank credit agreement on Feb. 28, 1943. The company's business was broadly diversified last year, according to Pres. F. C. Crawford, predominately in connection with the aircraft industry. Output of the Tapco division is expected to reach $8,500,000 a month.

**Commercial air transport** operations will continue on the same scale as during the latter part of 1942, Pres. Jack Frye, of **TWA,** told stockholders in his annual report, unless additional equipment is released to the airlines. Because of lowered mail rates, he added, mail revenue will probably decrease, despite increases in volume of mail carried. The company reported net profits for 1942 of $2,176,035 or $2.29 a share compared with a deficit of $487,613 in 1941. Fees earned under various government contracts, Frye said, amounted to "only a small portion of the net profit."

**Republic Aviation Corp.,** in its report for 1942, showed net profits of $1,105,061 equal to $1.02 a common share compared with $781,119 or 69c. in 1941. A reserve of $1,000,000 was set up for possible postwar losses on inventories and contingencies.

**Packard Co. officials** stated in the firm's annual report that the company would resume motor car production after the war but did not definitely commit themselves in the aircraft engine field. To quote: "Whether we shall continue in the special engine fields with designs for peacetime use will depend largely on market conditions. We recognize the desirability of broadening our market through diversification and are carefully considering these possibilities." Packard reported net earnings of $4,726,237 or 31c. a share in 1942 compared with $2,061,323 or 14c. a share in 1941.

**Piper Aircraft Corp.,** in the year ended Sept. 30, 1942 which marked the company's transition from peacetime to war production, reported net earnings of $115,365 or 75c. a common share as compared with $210,883 or $1.44 a share in 1941. A reserve of $185,000 was set up for contingencies. Including that reserve, earnings last year came to $2.09 a share. Sales were $5,307,749 against $4,679,507 the preceding year. Private plane sales were shut off in the second quarter of the year and the company augmented its sales of "grasshoppers" to the government with contracts from the Signal Corps. Pres. W. T. Piper expressed optimism regarding the prospects for 1943, saying that current contracts would "keep us busy well into 1944." He added that present contracts would be met on schedule and operations could be maintained at higher levels if an adequate supply of materials could always be obtained. Common dividends have been deferred until such time as working capital position has improved.

**Here and There**—Changeover by **Thompson Products** to peacetime production after the war's end will be a relatively minor problem, according to Pres. **F. C. Crawford,** since the company's products for the aircraft and automobile industries should continue to find wide markets . . . Directors of **Inter - Island Steam Navigation Co.** have voted to invest up to $2,000,000 in new stock of **Hawaiian Airlines, Ltd.,** provided the latter's application for a Honolulu-Los Angeles airline route after the war is granted . . . **Boeing Airplane Co.** paid a dividend of $1 a share in April similar to the amount declared last July . . . **National Aviation Corp.** is reported to have sold its interest in the **Vidal Research Corp.** to oil company interests . . . J. T. Trippe, president of **Pan American** sold 4,500 shares of the airline's shares in January, thus reducing his holdings to 44,913 shares.

## On the Raw Materials Front

PROGRESS IS REPORTED by War Production Board officials in meeting the serious shortages in alloy steel for aircraft that cropped up shortly after the first of the year. A lack of coordinated planning in steel distribution, shortsighted ordering practices, and confusion in all the necessary paper work have been held responsible for the shortage.

The fact is that the plane makers now take about 20 percent of the nation's entire alloy steel supply, and suppliers haven't been able to keep pace with the rapidly increasing plane production. The average time it takes, from shipping raw material to wheeling a newly completed plane out the factory door, has been reduced from nine months' in the last quarter of 1942, to less than seven months today.

Attempts to smooth out these alloy steel difficulties are producing results through the coordinated efforts of the Aircraft Scheduling Unit, Aircraft Material Command, and Aircraft Resources Control Office, on the one hand, and the steel section of the WPB on the other.

One of the things they are doing is to keep a closer check on inventories. Arrangements have been made to inspect the steel inventories of about fifty of the largest aircraft manufacturers and to check their monthly consumption. WPB officials assert that the amount of processed alloy steel in the hands of the plane makers exceeds the consumption rate. By means of the inventory inspection, they believe, surplus stocks can be located and corrected by curtailing further allotments and redistributing surplus until supply and demand are in better balance.

Then, too, 26 warehouses have been designated in strategic locations and adequately stocked with standard grades and sizes of alloy steels for use by the aircraft industry. Company officials have been notified in detail of the materials they may secure at these warehouses.

Small orders for items not carried in stock will be handled by instructing mills to roll the prescribed quantities and ship the full amount to a central warehouse. There the order will be filled and the balance held for future orders.

The amount of reserve steel held for emergencies also is being increased. Approximately 95 percent of all aircraft melting schedules will be determined by the first of each month with the remaining 5 percent held for emergency orders up to the tenth of each month. Heretofore, the reserve was 2 percent.

Boeing Flying Fortress taking off . . . Hayes equipped.

# MAYBE IT'S YOUR KID WE'RE WORKING FOR . . .

On the world's war fronts—the work of our hands and brains and machines is in ACTION—in the hands of our forces.

Who knows who "they" may be? Maybe a son, a husband, father, brother or kin of ours. OR YOURS! That front line today reaches into every home and factory of America—and by ties of blood and duty, we're **all** working for THEM!

As evening comes on—it will be daylight of tomorrow out in the South Pacific . . . and it'll be dark in Africa and Europe.

But don't let it be dark for them because we ever let them down at home.

And don't let a day dawn on them with the helplessness of empty-handed rage because SOMEONE failed back where FIGHTING PRODUCTION begins. It takes more than guts to fight this war, the way it's being shot at our boys. It takes everything they can get their hands on—planes and tanks, guns and ships and shells and bombs, and all that goes with them.

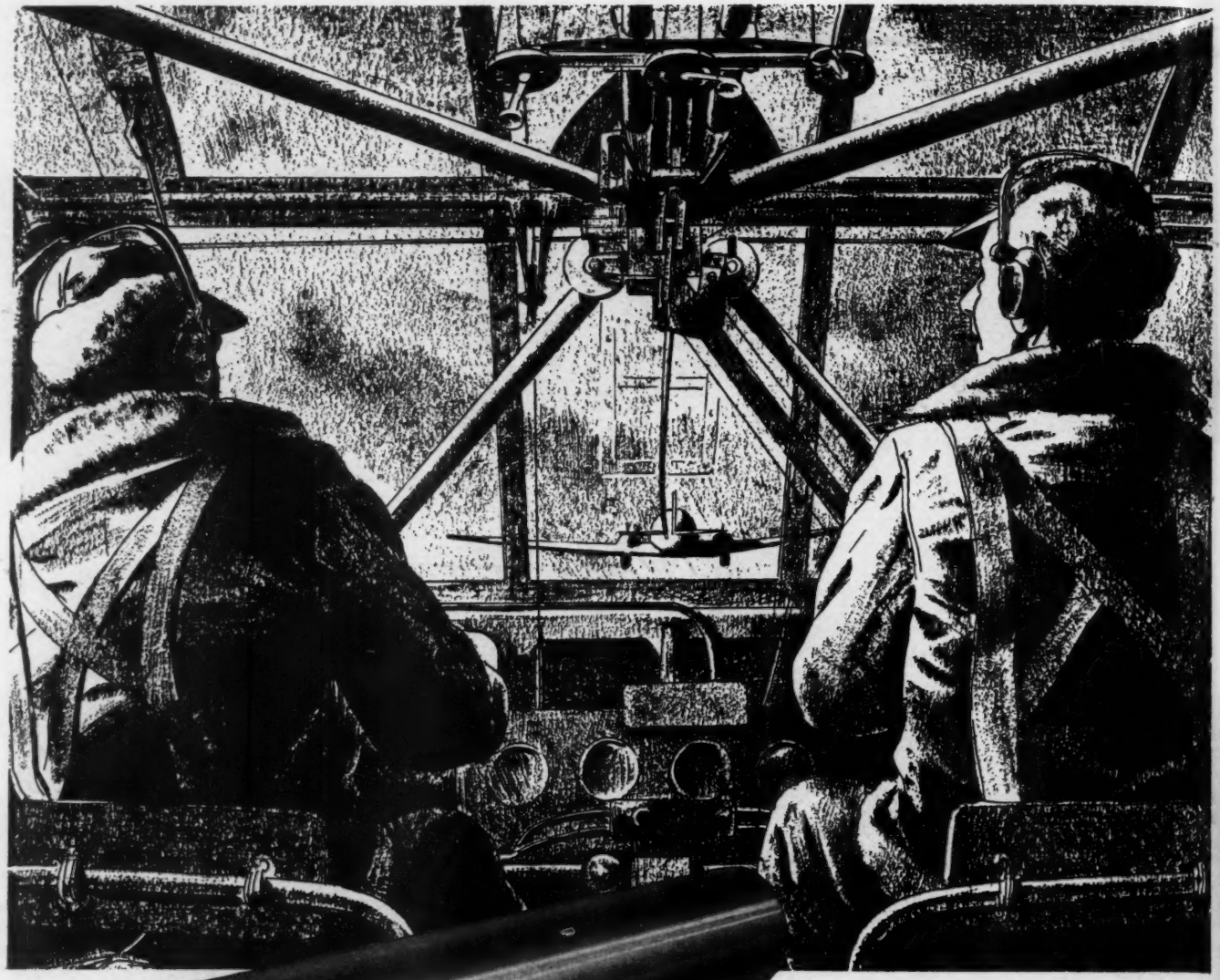
Let America's war workers be able to say, "Okay, son—we're in there pitching for you every minute. Give it to 'em your own way, kid!—We'll back you up!"

*—The men and women of Hayes Industries.*

Representatives: *Western . . . Airsupply Co., 5959 W. 3rd St., Los Angeles.*
*Eastern . . . J. Henry Reisner, Hagerstown, Md.*

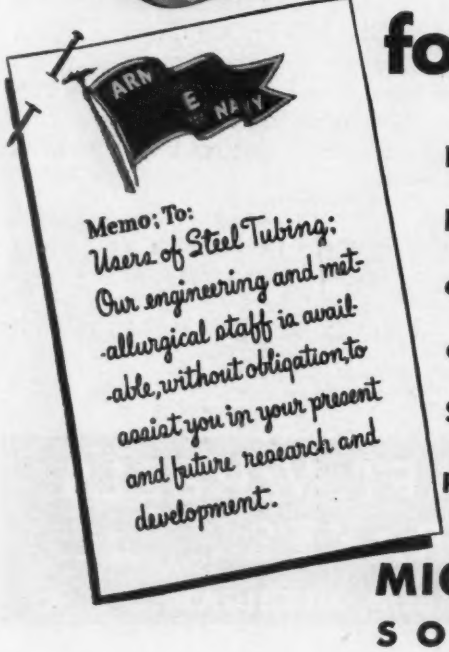
**HAYES** AIRCRAFT WHEELS AND BRAKES . . .

HAYES INDUSTRIES, INC. Home Office: JACKSON, MICHIGAN, U. S. A.



# STAMINA

## for the Silent Air Armada




**High above its carefully chosen objective, a military glider cuts loose from its tow plane and silently completes its course, alone. From that moment, the success of its mission hinges on the skill of its pilots and the stamina of its construction. Seamless steel tubing is an integral part of that stamina, providing maximum strength with lightness of weight.**

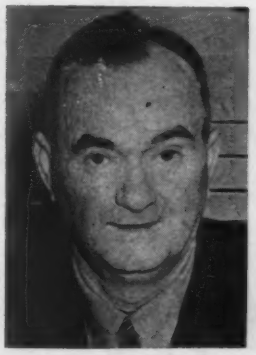
**MICHIGAN SEAMLESS TUBE COMPANY**

**SOUTH LYON ▲ MICHIGAN**

# Aviation People

**JAMES A. PIGUE,** Vultee safety director, has been appointed special safety agent for the United States Department of Labor. His new duties will be to contact plant managements to help them initiate and carry through safety, health, and first aid programs.

**COL. JOHN S. ALLARD** with **JOHN JR.,** following his recent return from North Africa. It will be recalled that he received the Silver Star for distinguished service during the Allied air attack on Oran, which he helped to direct as an operations officer under Maj. Gen. Doolittle. He was decorated after being exposed to French air attack and artillery fire during the American invasion. A former vice-president of Curtiss-Wright Corp. and director of Wright Aeronautical, he joined the Army Air Forces last July after obtaining leave of absence from the corporation.



**CAPT. JAMES H. CRAINE,** former operations superintendent of Pan American's Alaska division, has been reassigned to Miami as superintendent of seaplane operations of the Eastern division. He is another PAA "vet", having logged 11,300 hr.

*Harris & Ewing Photo*

**EDWARD E. SLATTERY, JR.,** is new chief of public information with the Civil Aeronautics Board. He was an aviation writer for several years, has extensive news writing experience, and was an aerial photographer with several hundred hours to his credit.

**FRED C. ESSIG** joins McDonnell Aircraft as factory manager of its Tennessee division. He was formerly co-ordinator and materiel supervisor at Douglas Aircraft, where he supervised liaison work with the manufacturers who shared in the initial Douglas subcontracting program.

*United Air Lines Photo*

**LT. ELLEN E. CHURCH,** the original airline stewardess and United Air Lines' chief stewardess, pioneers again: She is a member of the first Army Air Evacuation Unit and is now in Africa. She helped conceive the idea of stewardesses and was the organizer of the 1st group.

*United Air Lines Photo*

**MELVIN T. BROCKMAN** has been named area manager for the air cargo department of United Air Lines, with headquarters at Chicago. For the past two years he was district sales manager of Plaza Express, and before that was associated with Universal Carloading.

**H. C. DECKARD** has been made manager of two divisions of the Aviation Corp., the Republic Aircraft Products division and the Northern Aircraft Products division. Prior to this appointment he was handling special production assignments at Ford's Willow Run plant.

**WILLIAM "BILL" M. STABLER** has assumed the service managership of Liquid Cooled Engine Division of the Aviation Corp. Formerly with Lycoming division, he helped build and test their first aircraft engine, then became special service representative contacting maintenance depots.

*Braniff Airways Photo*

**AYRES COMPTON** has been appointed new publicity director for Braniff Airways. He is an ex-newspaper man who owned and published his own Texas paper. He organized Dallas' traffic safety program.

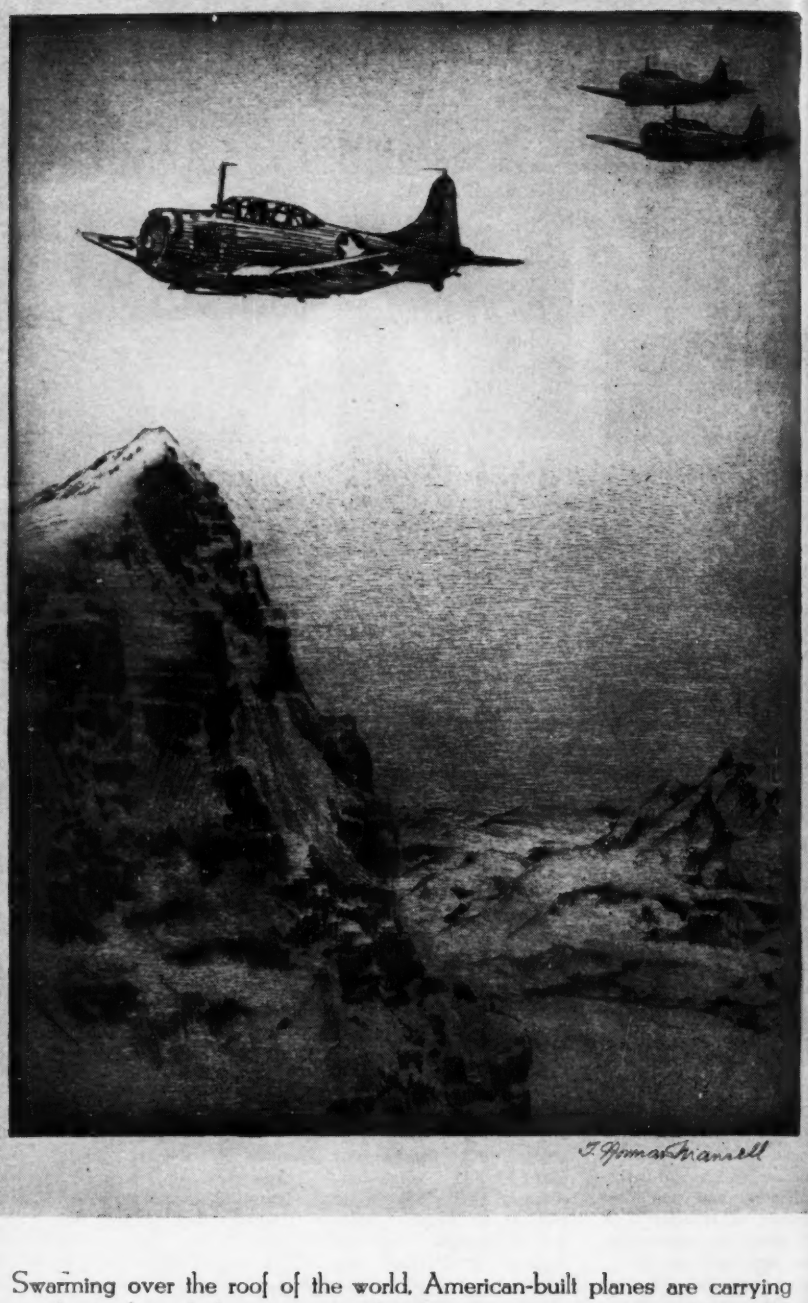
**MAJ. ALGENE E. KEY** was awarded the D.S.C. for extraordinary heroism while participating in a bombing mission. Subjected to a direct nose attack he maneuvered his plane, saving the ship and most of the crew.

**FRANK N. M. BROWN,** head of Notre Dame's aeronautical engrg. dept., has been commissioned by the U. S. Dept. of State to aid in the organization of aeronautical education in Chinese universities.

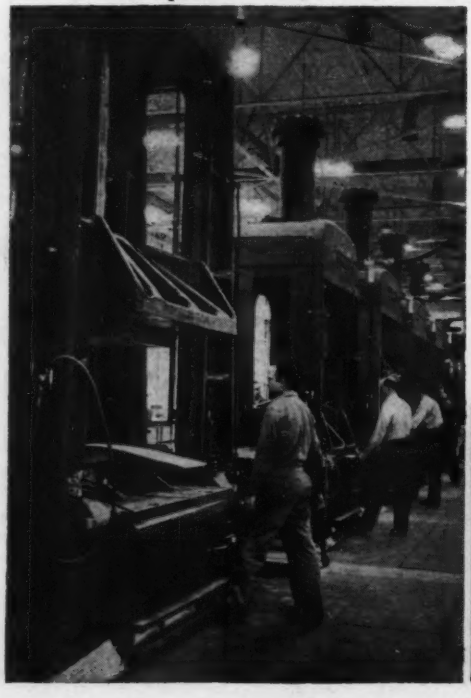
**FRANK W. HULSE** has become president of one of the largest fixed base airplane operations in the country with the recent merger of Southern Airways and Georgia Air Service into Southern Airways, Inc.

**ARTHUR W. F. GREEN** has been named materials-engineer administrator over the heat treating and plating divisions of N. A. Woodworth Co. He is a member of WPB's committee on aviation materials.

# Cecostamps help speed 'em on their way



*CECOSTAMP Department in large Aircraft Factory*



Swarming over the roof of the world, American-built planes are carrying on the traditional determination of our country to resist aggression, by peaceful means if possible, by force to the utmost if necessary. Part of the job of producing enough planes to stop the Axis is the production of sheet metal parts of light weight, high strength alloys, parts that must be formed rapidly and without reduction in section. The success of the Chambersburg CECOSTAMP in doing this job is reflected in the increasing numbers in practically every aircraft factory and in the increasing number of parts that are being made on the CECOSTAMP.

CHAMBERSBURG ENGINEERING CO., CHAMBERSBURG, PA.

**CHAMBERSBURG**

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# Recent Books

**Mitchell, Pioneer of Air Power,** *by Isaac Don Levine. Duell, Sloan and Pearce, New York. 420 pages, index, bibliography of Mitchell's writings, illustrations, $3.50.*

"The average man suffers very severely from the pain of a new idea," Adm. Sims told the House Naval Affairs Committee investigating the reluctance of the services to heed some of Gen. Mitchell's plans and prophecies.

Other people's emotions were the rub in Mitchell's career. Like a Bunyon he stood above his contemporaries in foresight and energy and swung his axe with the force of conviction. But the chips fell on men of shorter vision. What Mitchell fought for seems hardly revolutionary now. As commander of the air forces of the first and second armies in France, he had personally proved the value of aerial reconnaissance, organized an armada unequalled in size till the Battle of Britain, and, with Pershing's approval, planned a paratroop invasion behind the German lines for the spring of 1919. He automatically concluded that "if we have sufficient air power, we need not be afraid of anything," and that the way to make air power effective was to organize a single department of national defense with co-equal land, sea, and air arms.

Officialdom, even after the sinking of the *Ostfriesland,* suffered painfully from the new idea. Mitchell persevered, and so, says Mr. Levine, "it was inevitable that the struggle for air power should turn into a struggle of personalities." Mitchell's personality won the press, public, and congress, but others held the final power and, in the era of Coolidge complacency, they termed the general a rebel.

What Mr. Levine has skillfully added to this oft-told, dramatic Washington battle are details of Mitchell's early life, dug out of his correspondence and writings, some of them unpublished. They bring into focus the personality hitherto buried in belligerency.

Mitchell was a man of firsts; his aggressiveness and ability would probably have carried him to the top in any field. He was the youngest student when he entered George Washington University in 1895; in 1920 he resumed the undergraduate work interrupted by his enlistment in the Spanish-American War. With the signal corps in Cuba he built more communication lines than any other outfit and learned Spanish. He helped lay 16,000 miles of cables and wires in the Philippines where the army had planned for 100. In Alaska he strung more wires and studied for the examinations that made him the youngest captain in the army. At 32 he was the youngest man ever assigned to the general staff; at 36 he learned to fly. He was the first American army man to fly over the European battle lines, ready with the first plan for an AEF air force, and won the distinguished service medal. After the war he sponsored the first aerial forest fire patrol and in fun landed and took off from a railroad track.

"One of that damn kind of soldier who is wonderful in war and terrible in peace," said Gen. Summerall who was obliged to relinquish the presiding chair at Mitchell's trial on grounds of bias. More documented by this present war is Gen. Johnson Hagood's opinion: "I believe that Billy Mitchell has done more for aviation in the Army than any other man since Wright invented the airplane." As an epitaph Mr. Levine suggests a line from the OWI report on American aircraft during the first nine months after Pearl Harbor: "The country paid in blood and defeat for the determined blindness of its peaceful years."

**Air Navigation,** *by P. V. H. Weems. McGraw-Hill Book Co., New York. 406 pages, illustrations, appendices, index, $4.50.*

This third edition of a standard text again illustrates how to prepare the novice to be a practitioner in a difficult field. Lt. Comdr. Weems, a master of his subject and a clear writer as well, covers navigation in thorough detail from systems of projecting charts to celestial avigation, which is finally illustrated with a chart of the *Guba's* 1938 flight across the Pacific.

"It is my purpose," he says, "to include in this book sufficient material for practical air navigation and to omit material which is of doubtful value in the cockpit." Thus the emphasis is upon dead reckoning and celestial avigation, each of which is divided into three carefully written chapters on theory, equipment, and practice. For learning avigation this book is first-rate equipment to guide any student's practice.

**The Navy Has Wings,** *by Fletcher Pratt. Harper & Bros., New York. 224 pages, index, illustrations, $2.75.*

Introduction of this civilian naval authority's account of naval flying carries "recruiting" color. Then the work becomes a speedy resume containing many facts, together with various viewpoints by the author. Psychological examinations, he points out, have reduced flight training failures 50 percent; of 1,000 candidates for flying service, 635 get wings; flight surgeons favor the idea of equipping planes with pressure cabins; and students don't get enough Link trainer instruction. Spicing the details are numerous anecdotes, including the story of a Midwestern flyer, aloft over the channel leading to New York Harbor, reporting a big red yacht marked with the owner's name—*Ambrose.*

**Conquest of the Air,** *by L. P. Jerome. Bruce Humphries, Inc., Boston. 107 pages, $1.50.*

To prepare prospective pilots for dual instruction, this book presents 17 lessons in aerodynamics and the handling of a plane.

**Aircraft Lofting and Template Layout with Descriptive Geometry,** *by Howard Thrasher. Aviation Press, San Francisco. 212 pages, paper bound, $3.50.*

Replete with problems and laconic explanations, this text was compiled by a foreman in the master layout department of Vultee Aircraft while an instructor in lines in a national defense school. Designed "to give the student [presupposedly a beginner] the practical knowledge of lines by first giving a good theoretical background," it contains four sections: Theory of descriptive geometry, theory and practice of template layout, common principles and theoretical problems of lofting, and general information.

**The First Century of Flight in America,** *by Jeremiah Milbank, Jr. Princeton University Press. 248 pages, illustrations, bibliography, index, $2.75.*

As an historian Mr. Milbank has made a valuable contribution to sources on aviation history. However, he regards his contribution modestly: "This outline history of aeronautics in the United States before 1900 has only scratched the surface."

His account is carefully subdivided into personality sketches. Where writers and historians have not bothered to dig, Mr. Milbank has discovered a mine of interesting nuggets. Among them: The first balloon ascension by an American was made near Baltimore on June 24, 1784, by 15-yr.-old Edward Warren, whose brief adventure has been overshadowed by Blanchard's subsequent 15-mile "voyage"; a long-distance record of 350 mi. in 9½ hr. was established in 1835 by Richard Clayton, who later carried non-postmarked newspapers as the first airmail cargo; William Black took the first aerial photographs (of Boston) in 1860; in 1861 T. S. C. Lowe,

who became the North's military aeronaut in the Civil War, started the first leg of a transatlantic voyage in Cincinnati but descended in South Carolina.

Lowe's misdirection was just one example of the problem which plagued every man who went aloft—navigation; balloons went with the whims of the wind. The task of controlling them remained unsolved for lack of money (most balloonists were long on imagination and short on cash), lack of a practical engine, and lack of knowledge. Ballooning has "fallen into the hands of men of small scientific knowledge, who mostly occupy themselves with airships to make money," one writer complained. There were also the rewards of flattery: "For days," one adventurer said after his first and only flight, "my advice upon picnic weather and other purely scientific subjects was sought after. Fair women wanted my photograph, and brave men wanted to know 'how it seemed up overhead where neighbors were scarce.'"

About 3,000 balloon ascensions, carrying 8,000 people, were estimated to have been made between 1800 and 1850. Between then and 1900, historians lost count, for flights were almost standard entertainment at fairs and circuses. But the problem of navigation was still unsolved. And alternate flying machines —airplanes, ornithopters, and helicopters had failed to materialize—except in dime novels. Kittyhawk was still a few years over the horizon.

**Facts on File Yearbook 1942.** *Person's Index, Facts on File, Inc., New York. 494 pages, $20.*

Here is a bound volume, with extensive index, of the past year's *Facts On File* weekly 8-page news summaries. Events are listed chronologically in brief paragraphs resulting in what Editorial Adviser Hendrik Willem van Loon calls "a card catalogue to everything that has happened during the previous twelve months." He might also have added "invaluable as a quick reference to yesterday's news."

**A. S. T. M. Standards on Rubber Products.** *American Society for Testing Materials, Philadelphia. 301 pages, bibliography, $1.75.*

Forty-one specifications and emergency provisions and methods on procurement and conservation of crude rubber are contained in this annual report prepared by ASTM's Committee D-11 on rubber products, which has also defined tests for chemical analysis of rubber products (tentative), tension, adhesion, compression, and ply separation. Other sections cover tests on hose and belting, rubber cement, and battery containers, also purchase specifications on electric gloves and mattings.

**Electrical Aircraft Instruments.** *Weston Electrical Instrument Corp., Newark, N. J. 36 pages, illustrations, diagrams, 25¢.*

In officially-approved style, this booklet describes to students, apprentice mechanics, and maintenance men the principles of electrical circuits and the construction and operation of ammeters, volt meters, tachometers, and temperature indicators.

**An Illustrated Outline of Weather Science,** *by Lt. Charles W. Barber, U.S.N.R. Pitman Publishing Corp., New York. 248 pages, $2.50.*

Diligently subdivided, notebook type, and thorough description of atmospheric components and resulting weather variations by the assistant officer of the aerographers' school at the Lakehurst naval air station. Includes map problems, examination questions, and tables.

**Before You Fly,** *by Pearle T. Robinson, Frederic A. Middleton, George M. Rawlins, Jr., and Joseph W. Phillips. Henry Holt and Co., New York. 568 pages, glossary, index, illustrations, $2.75.*

Presupposing little scientific knowledge and none on aviation among their prospective readers, two flying school teachers (Mrs. Robinson and Mr. Middleton) and two doctors of philosophy (Mr. Rawlins and Maj. Phillips) have crammed into this book for high school students simple, short explanations of aviation—history, possible careers, aerodynamics, structures, engines, instruments, meteorology, and avigation. The result is on the whole an adequate and readable introduction to the field.

**A Start in Meteorology,** *by Armand N. Spitz. 95 pages, diagrams, index.*

**Air Navigation for Beginners,** *by Scott G. Lamb. 103 pages, diagrams, index. The Norman W. Henley Publishing Co., New York. $1.50 each.*

Prepared with the cooperation of Mrs. Harry T. Jordan, national wing commander, junior air reserves, NAA, both these books are for young people expecting to go into aviation. They contain simple resumés of weather and avigation facts.

**How to Fly an Airplane,** *by Bernard Brookes. Consolidated Book Publishers, Chicago. 223 pages, illustrations, nomenclature.*

For young people anxious to become pilots, Capt. Brookes, of the Ferry Command, has here dramatized basic flight instruction in a series of ten simple lessons with additional notes on parachutes, instruments, gliders, and bombers and bombardiers. Through illustrative dialogues between an instructor and a student, he demonstrates simple turns, takeoffs, landings, and acrobatics, with the maneuvers clearly diagrammed in color along the margins.

**How Aeroplanes Fly,** *by W. O. Manning. Oxford University Press, London, New York. 64 pages, paper bound, 85¢.*

Thorough, brief explanations of the hows and whys of flight. The lessons, which demand close attention but provide concise answers, cover the atmosphere, wings, controls, propellers, engines, and types of planes. Recommended as a simple, digested though not exhaustive exposition of principles.

**Why Men Can Fly,** *by M. K. Chapin. Reynal & Hitchcock, New York. 338 pages, index, drawings, $2.50.*

With historical notes on man's conquest of the air, this book presents to laymen a clear, popular-scientific account of the principles of aerodynamics, structure of airframes, engines, instruments, and notes on weather and weather forecasting.

**High Adventure,** *by A. H. Cobby. Published by Robertson & Mullens, Melbourne. 203 pages, appendix, illustrations, 6/6.*

Experiences of an Australian aviator over the front lines 1914-18.

**Basic Mathematics for Pilots and Flight Crews,** *by C. V. Newsom and Harold D. Larsen. Prentice-Hall, New York. 153 pages, index, $2.*

Comprises review, from arithmetic through vectors and right triangles, for pre-flight students.

**Plane and Spherical Trigonometry,** *by William C. Brenke. The Dryden Press, New York. 269 pages, index, appendices, four-place tables, $1.90.*

Two chapters in this trigonometry text cover formula solutions for spherical triangles and their applications to avigation and astronomy.

**Aircraft Propeller Handbook,** *by Karl H. Falk. Revised edition, The Ronald Press Co., New York. 146 pages, index, $4.50.*

Determination of factors and performances of propellers are carefully explained in equations and graphs by the blade designer for Hamilton Standard propellers in chapters on strength, static, gyroscopic, vibration, and aerodynamic characteristics.

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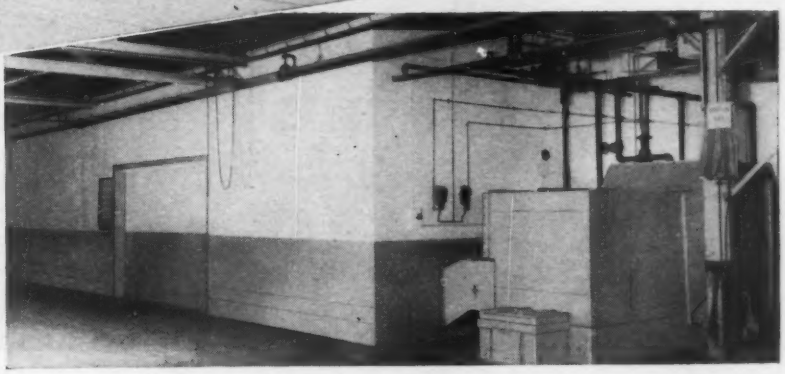

*Above:* Four of the modern Autoclaves recently installed and now operating, range in size up to 38 feet in depth.

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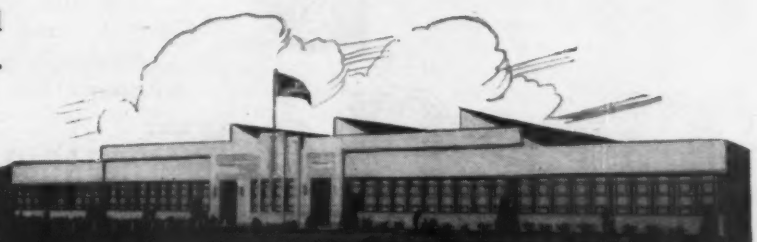

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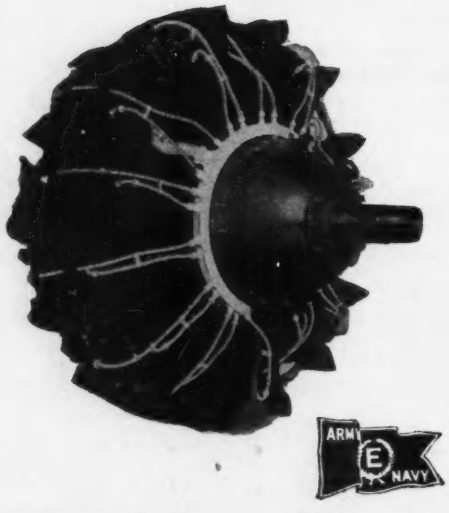


TO help our bombers reach the target *undetected* is one of the important functions of the TITEFLEX Radio Shielded Ignition Harness. With all ignition wiring virtually *sealed* within the TITEFLEX shielding assembly, powerful tell-tale signals from the planes' ignition system are not transmitted to enemy detection devices.

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**RADIO, POWER, AND IGNITION SHIELDING—CONDUIT, FITTINGS, COMPLETE ASSEMBLIES—HIGH PRESSURE FUEL, OIL AND AIR LINES**

# Power Generation from Aircraft Engines

(*Continued from page* 165)

ling and absorbing entire engine load in the coupling.

2. Disconnecting alternator from the a. c. power system and load alternator on a resistor bank.

3. Supplying low voltage d. c. excitation to stator winding and loading engine on generator damper winding.

The first scheme will usually be found to be more economical and simpler to operate.

Effect of correct choice of alternator speed on total kwh. delivered back to the plant distribution system may readily be seen from Table II which charts a complete test on one engine.

This indicates that a proper selection of this type of equipment will recover from 65 to 70 percent of total power generated. In one plant this recovered power exceeds 50 percent of the power required to operate the engine plant.

### Direct Current Generator Testing

This method (Fig. 3) provides the only means of recovering all power delivered by the engine excepting losses in the electrical machines. Smaller engines tested over a speed range not exceeding 2.5 to 1 may be tested using a single d. c. generator. In the larger ratings above 1,000 hp., the more economical method usually results in two duplicate machines of equal rating. They are connected electrically in series at lower testing speeds and electrically in parallel for higher testing speeds.

In order to recover power over the entire speed range, a separate motor generator set is required for each test cell. For a large number of test cells, the amount of equipment and corresponding cost may be reduced by using one motor generator set for a pair of test cells. The motor generator set in this case would have a single a. c. motor and a separate generator for each test cell. The testing d. c. generators with their control are comparable in cost to the alternator and slip coupling with their control. Addition of the motor generator set, therefore, makes this method most expensive of all power recovery or feed-back systems. Additional power recovered will not justify the cost of mg. sets and building space for the sets.

Two comparisons of relative costs, for the testing equipment only, serve to illustrate this point. Cost for the alternator equipment includes a hydraulic coupling. The price of motor generator sets is not included in the d.c. test equipment (see third column of Table III).

**TABLE III**

| Engine Take Off hp. | Engine Prop. Shaft rpm. | Cost of d.c. Equipment | Cost of Alternator Equipment |
|---|---|---|---|
| 1,400 | 1,260 | $23,000 | $22,300 |
| 1,850 | 1,020 | 32,000 | 30,200 |
| 1,200 | 1,510 | 22,000 | 21,500 |

### Wound Rotor Induction Generator Testing

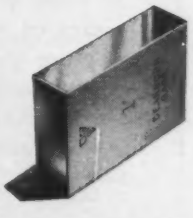
Production testing (Figs. 4 and 5) with a wound rotor induction generator is almost identical in operation and in power recovery to testing with an alternator and slip coupling. A secondary or rotor resistor, controlled by a motor driven drum, is used to regulate load for the engine. This compares with adjusting field strength of the electric coupling or oil level of the hydraulic coupling. The proportion of engine power absorbed by secondary resistor is proportional to the difference in speed between generator rotor r.p.m. and generator synchronous speed. This is the same power as would be absorbed by the slip coupling. Hp. absorbed in secondary or loading resistor is:

$$\frac{\text{Engine b.hp.} \times (\text{Gen. rpm.} - \text{Syn. rpm.})}{\text{Generator rpm.}}$$

Horsepower delivered to generator primary winding is:

$$\frac{\text{Engine b.hp.} \times \text{Synchronous rpm.}}{\text{Generator rpm.}}$$

**Make sure he gets it by using the *finest* standards available . . .**



Today, manufacturers are working to closer tolerances on production lines, to meet the exacting specifications of our Army and Navy. It is, therefore, important that they have the *best* checking gages and instruments to meet these tolerances. This is the reason why the Dearborn Gage Company's Chromium Plated Gage Blocks are preferred by manufacturers who recognize their superior accuracies and longer wearing qualities. Yes, Dearborn gages cost more, because they are worth more to the manufacturer.

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*Originators of Chromium Plated Gage Blocks*

That part of engine power delivered to the generator primary is converted into electrical energy and fed back into the plant distribution system.

In operation, the engine is cranked by starting the induction generator as an induction motor. The secondary resistor is adjusted by the motor driven drum to reduce cranking torque within safe mechanical limits for a new engine. When the engine reaches required speed for firing or at the end of a selected time of cold cranking, the ignition switch is turned on. The engine throttle is opened to give desired testing speed and the loading drum is set to give correct value of secondary resistance for test load.

For convenience of the operator, a chart is prepared in advance indicating correct numbered position of the loading drum for various testing loads. The small motor used to rotate the loading drum is controlled by an electric or control switch. A numbered dial on the switch assists the operator in setting loading drum on desired point for test. A further convenience to the operator are "synchro-tie" motors with numbered dial for indicating at the operator's desk when loading drum has reached the numbered position as selected by him.

That power which is absorbed by the slip coupling in alternator loading is absorbed by secondary grid resistors. These resistors are forced air-cooled to reduce size and weight for the larger engines. A convenient location for the resistor room is above test cells. Cooling air is drawn in from outside and discharged through roof to the atmosphere.

Cost of this type of equipment is comparable to that of the alternator with a slip type of coupling. Usually the wound rotor generator with its loading resistor and control is 10 to 12 percent less. The most economical speed for the generator is 65 to 70 percent of rated engine propeller shaft speed, for testing engines with a single gear reduction ratio. In case the equipment must test two or more gear reduction ratios, the choice of generator speed is of necessity a compromise. Generator synchronous speed is then largely determined by lowest engine testing speed. When total testing speed range for all engine gear reduction ratios is extremely wide, it may be found necessary, and in some instances an advantage, to disregard power recovery at these lower speeds and loads.

In this case, the primary of the generator is disconnected from the a.c. line and excited from a low voltage d.c. source of power. All engine power will then be delivered to the loading resistors. This adds somewhat to cost of the equipment and to work performed by the operator. It is, therefore, usually not considered, except where requirements so demand. With several gear ratios, power recovered will be lower for all engines than with a generator picked for each engine gear ratio. Preliminary figures indicate that one plant, using wound rotor induction generators for testing engines with three different gear reduction ratios, will recover 50 percent of the total engine test energy. This is 38 to 40 percent of power required to operate the plant. Valued at .4c. per kwh., the power recovered would be worth approximately $400,000 per year.

### Determination of Engine Brake Horsepower

In addition to determining engine power from exhaust manifold pressure, engine brake horsepower may be determined by electrical instruments when used in conjunction with power recovery equipment. Also, the electric brake, alternator, direct current generators, or wound rotor induction generators may be equipped with special mechanical parts to measure the torque reaction. These parts consist of trunion bearings, torque arm, and scale.

The engine b.hp. $=$ $\dfrac{\text{Torque in ft./lb.} \times \text{prop shaft rpm.}}{5{,}250}$

(*Turn to page* 355)

★ In your finishing operations, be they metal, wood, plastic or what-have-you, you can erect tiny monuments to wasted man hours and lost material because of rejects. Or you can maintain a finishing schedule with a plus of increased production, better finish and lower operating costs.

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One Sunday afternoon, while working on the problem in his attic workshop, a G-E engineer happened to notice a translucent, plastic-handled kitchen paring knife on the workbench. That gave him an idea. In a matter of minutes his lathe was biting into the plastic handle of the paring knife. Out came a nicely turned dome-shaped piece of plastic ... which he used as a color cap for the surgical instrument lamp. Combining these two with a proper lamp base, he soon had an experimental bomb indicator lamp the Army wanted.

This lamp, after weeks of intensive experiment, served as the model for thousands of G-E Bomb Indicator lamps now on the instrument panels of our bombers. Thus, a glance at the indicator lamps on the instrument panel quickly tells a pilot how many bombs have been dispatched and how many remain.

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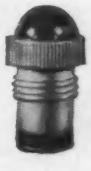

**This is the bomb indicator lamp** that a kitchen paring knife helped develop. General Electric research has produced more than 150 new designs and types of lamps for military uses since the war began.

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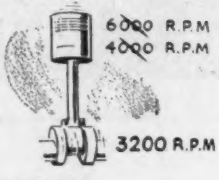


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**The Andover Auxiliary Motor features a low 3200 R.P.M. speed which assures long life, complete dependability and attention-free performance. It furnishes electric power for bomb hoists, motor starting, operation of gun turrets, galley hot plate, lights, heating, instruments, interplane communication, radio and ventilation equipment.**

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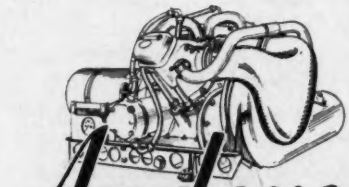
*The Andover Auxiliary Motor is a 2-cylinder air-cooled engine driving a 28-volt generator supplying a continuous power output of 5 K.W. with a peak load of 7½ K.W. for five minutes. Its complete weight is only 125 pounds.*



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These special mechanical parts are quite expensive as compared to the electrical instruments. Due to lack of sufficient operating experience, relative accuracy of the electrical metering method as compared to the torque reaction method has not yet been definitely established. The torque reaction method, as commonly used on the cradle type dynamometer, will conservatively determine engine power within plus or minus ½ percent of true value. The electrical instrument gives promise of determining true engine power within plus or minus 1 percent.

### Power Determination With an Alternator

A watt-hour meter of high accuracy is used to measure power output from the alternator for a definite time. The time may be measured by an electric clock. Also, the watt-hour meter and an electric revolution counter may be operated for a definite period by manual starting and automatic cut-off. A test calibration curve for the alternator indicates horsepower input to the alternator versus kw. output as measured on the kwh. meter. Alternator losses are included in the curve.

Since the alternator operates at constant speed, this horsepower input is proportional to shaft torque of the alternator or torque of the hydraulic coupling output shaft. There is no loss of torque in the hydraulic coupling. Therefore torque of the coupling output shaft and input shaft are equal. The coupling input shaft torque is the engine propeller shaft torque. Therefore, a single curve may be plotted of kwh. meter reading for one minute versus engine propeller shaft torque. The revolution counter in the same minute gives engine prop. shaft rpm. Engine b.hp. is then calculated by—

$$\frac{\text{Prop. shaft torque} \times \text{prop. shaft r.p.m.}}{5{,}250}$$

### Power Determination with Wound Rotor Induction Generator

The same watt-hour meter, revolution counter, and timing device are required as for alternator testing. The electrical horsepower transferred to the stator winding is—

$$\text{Stator hp.} = \frac{\text{Engine b.hp.} \times \text{Gen. Syn. rpm.}}{\text{Generator Rotor rpm.}}$$

The stator horsepower equals the horsepower delivered back to power supply plus electrical losses. Generator rotor rpm. are also propeller shaft rpm. The generator synchronous speed is a constant.

Therefore, electrical input to the stator winding is proportional to prop. shaft torque. A test calibration curve for the wound rotor generator indicates shaft


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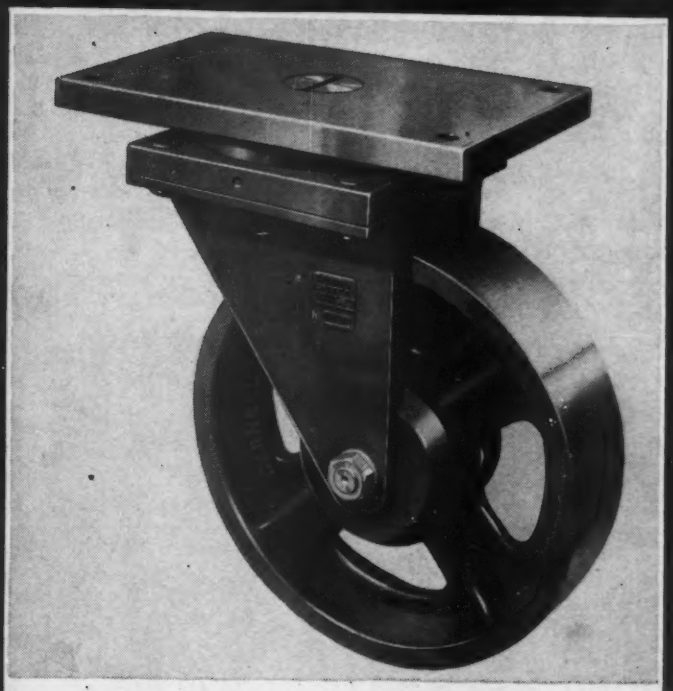

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torque versus meter reading for one minute, and the engine b.hp. is calculated as before.

### Protection

Power recovery apparatus presents a ready method of protecting both engine and test equipment against dangerous or faulty operation. The following are recommended as a minimum of protection by shutting down the equipment. Protection of—

1. Engine and testing equipment against overspeed
2. Loading equipment against overloads
3. Motors driving exhaust and supply fans
4. Engine against loss of cooling air
5. Equipment against power failure
6. Engine against loss of lubricating oil pressure
7. Engine against loss of cooling liquid

Items 3 and 4 apply to aircooled engine; Item 7 for a liquid cooled engine.

The following danger operations should operate in an annunciator system but need not necessarily cause an emergency shutdown:

1. Excessive temperature of windings of loading generator, supply fan motor, and exhaust fan motor
2. Excessive temperature of loading generator bearings
3. Low engine fuel pressure
4. Low engine oil pressure
5. High scavenging engine oil temperature
6. High crank case pressure
7. Clogged oil filter by-pass
8. Low compressed air supply for air operated valves
9. Positive air pressure in engine test cell
10. High exhaust air temperature for aircooled engine
11. Low oil level in oil weighing tank

All prices and cost figures are approximations for comparison purposes only and hence cannot be regarded as purchasing prices.

## Reduction of Man-Hours

(*Continued from page* 173)

lowering of man-hours consumed in *Liberator* manufacture—a cause which was the outcome of a combination of chance and headwork. The building in which the *Liberator* final assembly line was to be set up was found to have bays which were too narrow to permit the line to operate with the 110-ft. wings at 90 deg. to the direction of flow.

The result was that the planes were turned to a 45-deg. angle. This gave plenty of space for all operations attendant to assembly and left ample space for the station stock bins and access thereto. In addition, the production line was figuratively 50 percent longer. That is, 33⅓ more stations could be put on the line with the planes at a 45-deg. angle than could be at a 90-deg. angle-to-production flow. So well did the *Liberator* 45-deg. angle final assembly line operate that it was installed at Fort Worth even though the nearly mile long building was wide enough to accommodate the plane at a 90-deg. angle.

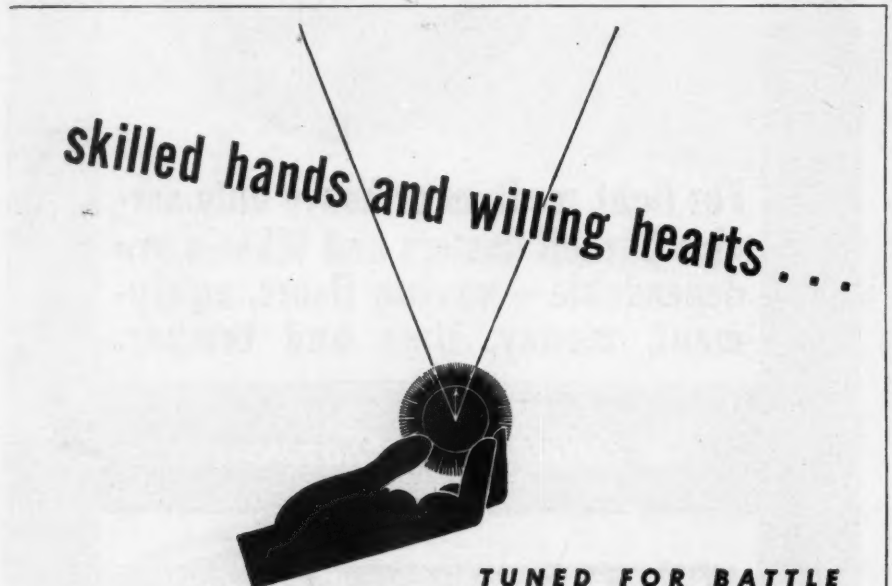
During the past year considerable conservation of man-hours has been brought about by establishing predetermined operating department controls inaugurated by Harry Woodhead, president of the company. Based on the comparison of standards to actual performance, these indicate the efficiency of operation and act as a measure of each and every department's status in the efficient use of the production facilities and manpower at its command.

Once standards have been established the next step is to check the performance of a department against them. From this check, which is a yardstick to measure every department, comes management's control of operations. The data gives management and the department heads a forecast of what can and must be done in sufficient time to make necessary corrections and plan their action accordingly.

Under operating control, not only is management advised weekly of the operations of the entire organization, but in addition supervisory personnel benefits from increased efficiency through a method termed the Foremen's Cost Conversion Bonus System. Based on comparative efficiency on a month-to-month basis, the improvement of performance in a department results in a bonus to foremen within that department. Each month a "bogey" is established, based on performance during the previous month, and this in turn becomes the "bogey" for the current month. To receive a bonus, the foremen must improve on the previous month's performance.

Those who share in the bonus are graded not only on improvement in performance, which is in actuality the lowering of man-hours per unit produced, but on housekeeping, safety record—both as to frequency and severity of accidents—and on the meeting of schedules, which has a direct effect on the subassembly and final assembly lines. Failure of one department may cause "starvation" on any of these.

In addition, foremen are graded on the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So we secured a number of stock NORMA-HOFFMANN Open Type Ball Bearings—some made 30-odd years ago, others at intervals since. These we dis-assembled and "mixed up"—interchanged inner rings, cages with balls, and outer rings—and reassembled them into complete bearings which were then subjected to our rigid PRECISION tests.

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performance of all other departments, which means that inter-department cooperation is promoted. If one department is doing an excellent individual job but is not cooperating with other departments, the efficiency of the entire organization suffers. General performance, and therefore production, is lowered. On the other hand, if departments are cooperating the general production standard is raised.

It has become increasingly imperative that the company's methods and conditions be constantly improved so that conservation of man-hours can be applied to the ever-increasing production schedule. The operating controls have proved eminently successful, not only as a production yardstick but in making supervisory personnel man-hour conscious and has done more than any other factor to step up the tempo of production.

Another element in saving man-hours has been the institution and operation of the supervisory Cost Improvement Proposal Plan. This phase of production engineering went into effect last August. Since then more than 4,500,000 man-hours per year have been saved as the result of actual installation of labor-saving methods and devices. Another phase of engineering for production is the Employee Suggestion System which has been in operation for some time but which was specially promoted with a concerted drive about ten months ago. Under this system, workers have been paid more than $30,000 in war bonds, stamps, and cash for suggestions which to date have resulted in savings of more than 700,000 man-hours.

Among the other ways man-hours have been saved are:

1. Long, complicated assembly operations which formerly had to be done by craftsmen who required several years of apprenticeship are broken down into small subassemblies which can be accomplished by "green" hands, including women totally inexperienced in any kind of factory procedure.

2. Increase in skill in tooling design methods, which has resulted in better tooling.

3. Better assembly fixtures developed over a period from the time the first *Liberator* came off the line up to the present time.

4. Better installation fixtures developed over the same period of time.

One example of the thousands of problems which have been licked was this: When Consolidated saw that hundreds of airplanes must be fabricated in place of tens in the latter part of 1940, the then seemingly astronomical goal of four planes per day was set. One of the problems which the company faced was that of making the fuselage nose installations fast enough. At that time, 6,000 man-hours were assumed to be required for each unit, and, at the same time, it was impossible to work effectively more than six people inside the assembled nose. On this basis, with six persons working on two 10-hr. shifts, a total of 120 hr. per day, it would require 50 working days to complete the job. In order to produce four planes a day it would be necessary to have installations under way in 200 fuselage noses at all times, requiring a line for this subassembly alone that would stretch over three-quarters of a mile.

The answer to this problem was found in opening up the fuselage nose, eliminating the cramped quarters, and permitting more man-hours to be applied simultaneously. Four cleavage lines were decided upon. These lines—two extending horizontally in the upper half of the assembly and two extending horizontally in the lower half—were not riveted. Once the nose was properly mated, it was dis-assembled, which made it possible to install equipment on all the separate panels and flight deck. The nose was then re-assembled, ready as a complete component, to go to the final assembly line.

The reason for building the fuselage


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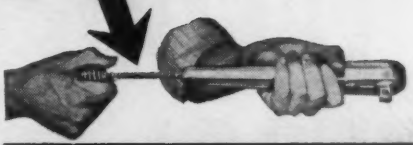

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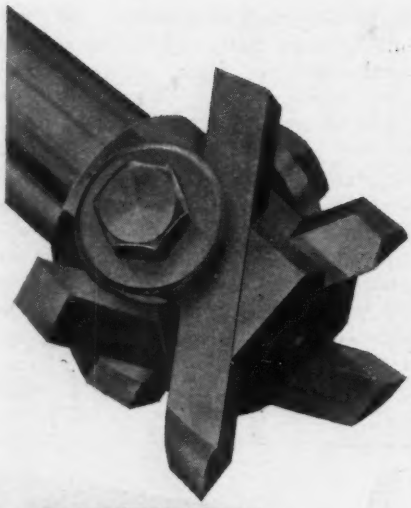

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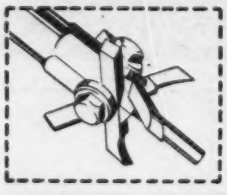

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nose as an assembly and later dis-assembling into the flight deck and other segments, was the time required to tool separately each segment of the nose. Separate tooling for each fuselage segment would undoubtedly save man-hours required in fuselage fabrication and eventually the company will have tooling of this type.

The step outlined above in cutting man-hours is only one of an almost incalculable number put in effect in the manufacture of the *Liberators*. As forecast, further methods and tooling are now being devised, more and more subassembly lines are being established, and it is anticipated that during 1943 many millions more man-hours per year will be saved.

Any attempt to credit any one specific person is out of the question. The production record is not due to the genius any individual or group of individuals but is based entirely on the fact that everyone within the organization is cooperating on the job of turning out aircraft as fast as possible under such handicaps as lack of trained personnel, labor turnover, continual expansion to meet constantly increased production schedules, and lack of production facilities due to wartime shortages.

## Hydraulic Efficiency of Rubber Pads

(*Continued from page* 169)

cated by the plugs visible on the machine in the photo of Fig. 1. The table accompanying this article gives results for each position, based on an average of five readings.

Gages used could be read with an accuracy of plus or minus 10 lb., causing an error of 2 percent in the results. This was especially noticeable in low pressure ranges. However, since the final results are an average of many readings, this error is minimized.

Effect of friction between the rubber and container wall is noticeable but very slight, and on a large pad this effect could be neglected. We can conclude, therefore, that when rubber is used as an hydraulic fluid, the pressure per square inch available for useful work is 90.5 percent of that applied.

## Points on Plastics in Aircraft Engineering

(*Continued from page* 190)

the material also affects electrical properties. Dielectric constants and the power factor of phenolic molded materials increase in proportion to the amount of water absorbed. The water absorption of some of the plastic materials reduces surface resistivity. Obviously, it is to the interest of the designer to make a thorough investigation of service conditions and to test thoroughly the plastic materials before final specification.

Data on six characteristic factors should be obtained by standard tests before specifying. The six factors on electrical properties are dielectric constant, dielectric strength, power factor, loss factor, insulation resistance, and arc resistance. This listing is not necessarily in the order of design importance, since the requirements of the particular application will determine the factors for further investigation. And of course, temperature and moisture conditions must be brought into the analysis before final choice and design is made.

The dielectric constant, or ratio of the capacity of a condenser with a given dielectric to its capacity with air as the dielectric, is usually measured at 60 cycles, $10^3$ cycles, and $10^6$ cycles. These constants are of particular importance in radio circuits. For comparative analysis, they are tabulated in the accompanying Table V. The values given are based on manufacturers' literature.

Dielectric strength, or the maximum voltage that a material will withstand before puncture divided by the thickness of the material, is expressed in mils. Two factors seriously affect this measure: The rate of voltage increase and the thickness of the material under test. Three methods of testing are approved and have been standardized by the ASTM. These are short-time test, step-by-step method, and endurance test.

Of these, the easiest to apply and the most commonly used is the short-time test, where voltage is applied at the rate of 0.5 kv. per sec. until puncture occurs. Material thickness is measured at point of failure. Dielectric strength is a function of temperature; the higher the temperature the lower the dielectric strength. As frequencies increase, dielectric strength decreases. With laminated plastics, tests made parallel to the laminations will give lower dielectric strengths.

Other factors that influence dielectric strength are fillers (mica-filled phenolics are high; graphite-filled are low) also manufacturing variables, and exposure of material to high humidity. Table V shows the approximate dielectric strengths as reported by manufacturers and which are available in materials

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customarily considered for electrical applications.

Power factor, or ratio of power loss in watts to the volt-amperes through a capacitor in which that material is the dielectric, is important in the design of radio frequency insulators. Moisture absorbing characteristics of the materials are important, as the power factor may change with absorption of water. For this reason, polystyrene has attained wide acceptance in the electrical field; its moisture absorption is practically 0 percent in 24 hr.

Phenolic materials of the "low-loss" type have mica-fillers. In manufacture, they are carefully dehydrated. As dielectric materials, however, they cannot compare with polystyrene in many applications. This material (polystyrene) has a power factor of 0.0001 at 60 cycles. Ethyl cellulose shows up well in the power-factor test. Value of the power factor is reported to be 0.0007, which should open up interesting possibilities for the use of ethyl cellulose in electronic applications.

Loss factor, or the product of power factor and dielectric constant, is of help in comparing materials, since it gives an idea of the heat generation rate per unit volume under certain test conditions. It must, however, be considered in relation to other electric properties.

#### Insulation Resistance of Plastics High

Insulation resistance of plastic materials is fairly high and ranges from $10^{18}$ ohms per cm. for polystyrene to $10^{10}$ for phenolic. Surface conditions will affect the insulation resistance, as will moisture and high temperatures. It will be found that moisture and temperature are particularly critical. Here again, the engineer will do well to make careful tests before proceeding too far. The ASTM has devised tests to be made under certain specified conditions of temperature and humidity. These will serve as a good measure of the material's ability *at the temperature and humidity conditions of the test.*

As to behavior at elevated temperatures, further testing and experience of others are the only guides available. Much work has been done on this subject, and the engineer will do well to consult with manufacturers before proceeding too far with his design.

Arc resistance is a measure of the behavior of the material under a power arc, to determine the amount of carbonization or "tracking". This property will have to be determined by separate tests, under procedure devised by the ASTM. It is important to consult the manufacturer if arc resitsance is a requisite of the design. Arc resistance is of particular importance in switch design. Often proper engineering can do much to reduce the danger of "tracking".

#### Moisture Resistance

The amount of moisture absorbed by the material will affect dielectric qualities, appearance, and sometimes dimension of the molded part. Polystyrene and vinylidene chloride show the least moisture resistance of all the plastics, the cellulose acetates behaving poorly in this respect. Some of the laminated phenolics are compounded for low water absorption to obtain better electrical properties.

## Setting Up the Engine Overhaul Station

(*Continued from page* 235)

our own manufacturers and tool makers to supplement the inadequate supply at hand. Therefore we went ahead and built all of our own engine stands, all special engine tools, assembly and disassembly fixtures, cleaning tanks, tool benches, inspection benches, cylinder honing stands, valve and cylinder testing equipment, an infra-red paint drying oven, a spark plug department complete with test bombs, magneto, and carburetor testing equipment, propeller protractor table and balancing stand, prony brake stand for inertia starters, engine handling equipment, dollies, etc., and a complete battery of engine test stands.

There was a great deal of ingenuity necessary on the part of all our various employees in order to improvise, adapt, or reconstruct types of commercial and automotive equipment to the above uses.

However, with the experience that Mr. Grafflin and his crew had secured at the various plants they had visited, they were able to do an admirable job of adapting this equipment to precise aeronautical requirements. In many cases they were able to improvise equipment which was actually better than standard ready-made units.

For example, the cylinder-honing stand is a novel set-up illustrative of the results of such improvisation. The stand was built of angle iron and plate in such fashion that the cylinders were adjustable in three positions. It was possible to affix four cylinders to the stand, permitting the honing and refacing of both valve seats on this fixture without removing them between the various operations.

The best outfit which we could obtain in prefabricated form would handle only one operation at a time. But with our


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unit, it is possible to hone the cylinders and reface valve seats on intake and exhaust ports without removing any of the cylinders from the conditioning fixture.

We designed and built a paint-drying oven, using infra-red drying lights, which permit cylinders and crank cases to be assembled within 30 min. from the time they are painted—compared to 2½ to 3 hr. necessary in the ordinary bake-oven method. Manufacturers had informed us that we could not get delivery on a similar outfit for months.

In Miami we located Samuel J. Constance, a man of 15-yr. automotive electrical experience, who learned the intricacies of aircraft magneto and acquired overhaul procedures in an exceedingly short time. He and Chester Kunkel were given a course in Scintilla magneto overhaul methods. Their past experience enabled them to grasp these operations quickly.

Next, we gave them the specifications and procedures required by the Army Air Forces in their technical orders and, with the help of the other supervisors and mechanics, they set up a magneto overhaul department to meet these requirements. Today, we believe this department is second to none in the country despite the fact that here again equipment, tools, and machinery had to be converted or made outright before they could be used.

For example, they converted an old-fashioned automotive type Wiedenhoff starter and generator test bench into a highly satisfactory aircraft magneto test stand by removing the works from the cabinet and installing them on a bench with adapters suitable for aircraft magnetos. Further, by installing infra-red lights, the men worked out a method of operating the magnetos under heat conditions and so provided a true test of the magneto operation.

Precious steel could not be wasted on a monorail set-up to transport finished engines from the overhaul depot to the engine test stand a block away, but an old Model A Ford could and would keep our production line moving. By stripping off the coupe body and installing a boom and carrier, engines are now moved quickly back and forth across the intervening yard.

An amusing sidelight occurred when the purchasing department men received the order for the Model A. A howl went up, since they wanted to know what use we would have for a pleasure car, and no gasoline was forthcoming until the body had been stripped.

Every department had its own illustrations of inventiveness as the work went forward and the demands of the war made it increasingly impossible to depend upon outside sources for help. The various departments were rapidly reaching completion, but there was still the vital and concurrent problem of highly specialized and trained personnel. Advertisements in newspapers and magazines would no longer bring in sufficient men, and it was futile to count on those of draft age because it was only a matter of weeks before we would loose them. We had to depend upon women to fill many of our positions.

We started with a class of 16 women, using the facilities of the Embry-Riddle technical school division to train them in the various specialties. It was necessary to teach them to read precision tools, gages, calipers, and micrometers, and train them in the fundamentals of engine operation and the functions of the parts they would work on in the engine in order that they would know what to look for and also appreciate the importance of their work.

Results obtained with women has been one of the most gratifying phases of this development. As inspectors, we found that their work is more accurate and more consistent than we had expected. This success prompted us to try them elsewhere, such as—the spark plug, carburetor, electrical, magneto, and other departments. They now constitute more

Tires on planes are actually "cushions of compressed air". They make high speed take-offs safer and soften the impact of landings. Ground crews know that the greatest safety for pilot, crew and plane depends on correct tire pressures. They know the important part Valve Caps play in maintaining tire pressures. Tires without the protection of air-tight Valve Caps would never pass routine inspection.

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than one-third of the employees in the depot.

We discovered that the women who had used their hands in the past, such as typists, seamstresses—those, too, who could play the piano—quickly became adapted to their new work.

Age range of the women is from 18 to 50 yr., and it is interesting to note the varied backgrounds which have produced these successful workers. There is a president of the Junior League, a show girl, models, housewives, and some who have operated various stores and businesses in the past.

It is evident that interest in their work is stimulated by a strong sense of patriotism. Perhaps this is true because many of them have husbands, fathers, and brothers in the armed services. One girl, whose two brothers are missing in the Pacific is an outstanding worker. Each finished spark plug, she hopes, will contribute to the death of a Jap.

A two-week training period, we find, is satisfactory for many of the women's jobs, and we are keeping this training program in operation to keep our labor supply constant.

Conversion of personnel as well as equipment is practical and necessary in this wartime effort. Another illustration of personnel conversion is Charles A. Pelton, our foreman in charge of final assembly. Formerly an automobile mechanic and garage owner at Miami Beach, he is keping our daily output right on schedule. The test stand results are proving the competency of each member of the staff all along the line.

One final difficulty faced us after the depot was set up and we had solved the problems of production and personnel: To meet Army schedules, it was necessary for a time to run our engine test stands constantly during the day and sometimes far into the night, with the result that the roar of the engines proved a serious annoyance both to the nearby technical school and residents.

The high-baffle wall in front of the open cells reduced sound only slightly. Finally we realized that the cells would have to be completely soundproofed. All walls were then lined with insulating material and covered with sound absorbing board. Doors have been built up the front and towers placed on top of the cells, with openings for the circulation of air. This soundproofing was expensive—but it has done the job.

Today, Army engines are arriving in a steady stream, being carried rapidly around the lot via the old Model A, moving through the depot with production line efficiency, and out to the test cells for complete testing. And each finished engine represents one more tribute to the home-front army of men and women who are determined that our planes shall fly through to final victory.


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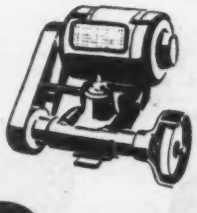
**DUMORE GRINDERS**  **HELP KEEP 'EM FLYING**

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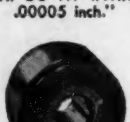

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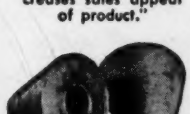

Cones for Wheel Balancing Machine "Accurately align hones two interrupted surfaces."

# Instrument Approach by Direction Finder

(*Continued from page* 225)

Referring to Fig. 1, it will be seen that the heading is 45-deg. for selected example. In order to be prepared to assume correct heading at this point and also on the various legs of boxing procedure, it is necessary to decide upon these headings well in advance of reaching the station.

2. At the completion of 1½ min. at an airspeed of 120 mph. and with gear lowered, make a standard rate turn to the left to a magnetic heading that is the reciprocal of final approach track (in this example 270 deg.). This becomes the intial boxing heading.

3. While making this first left turn, check position of the station by rotating loop to hold the null signal. This provides a double check of station passage in the event that there exists any doubt after receiving an "over." Prior to completion of the turn, set loop in readiness to receive the first abeam (loop null position at 90-270 deg. on the azimuth scale). With a sweep second watch check time necessary after the turn to receive this first abeam. With no wind this will be very close to 1 min.

4. Continue past abeam position for exactly the same time as it took to reach it (1 min.) and then execute a 90-deg. left turn to next boxing heading, 180 deg.

5. Continue on this heading and determine the time needed to receive second abeam.

6. Continue on this heading for the same time past the abeam as it took to reach it, then execute a 90-deg. turn to third boxing position, 90 deg.

7. On this heading determine time necessary to reach third abeam position. Continue past it on the same heading for exactly the same time as it took to reach it before making a 90-deg. left turn to fourth boxing heading (0 deg.).

8. Continue on this heading until fourth abeam is received and note time necessary to receive it.

9. Continue past the abeam for the same time needed to receive it and make another turn to the left of 90 deg. in order to parallel original boxing heading.

### C. Analysis of Boxing Procedure

The procedure explained above from Position 1 to Position 10 in Fig. 1 constitutes the so-called boxing procedure. Its purpose is to furnish the pilot with a close approximation of existing wind direction and velocity in much the same manner as a double drift problem does in dead reckoning. At the same time the pilot is assured of remaining within immediate vicinity of the radio station.

If no wind exists, the ground pattern flown will closely duplicate the air pattern shown in Fig. 1, provided the pilot uses care in timing the various legs. In this case all sides of the square will be nearly equal.

### D. Boxing Station-Compensating for Wind

Usually, of course, wind effect will exist and alter ground track from the no wind pattern shown by Fig. 1. The boxing process, however, will disclose this fact to the pilot as he progresses around the station and furnish him with a close approximation of existing wind. While exact wind direction and velocity is not readily obtained, the pilot can, by estimation, establish wind direction and alter his timing on the four sides of box to compensate for wind effect. *The skill with which this knowledge is applied to the problem is the essence of any boxing procedure and approach by the D/F.* (Refer to Fig. 2.)

Let us assume that unknown to the pilot there prevails a wind from 270-deg. magnetic at 40 mph. (actually while making initial approach, the pilot would know he had a wind from the left). The same boxing procedure explained previously for a no-wind condition would work out as follows:

1. As before, after passing the station, a heading of 45 deg. is maintained for 1½ min.

2. A left turn is then made to first boxing heading of 270 deg.

3. This heading is maintained until first abeam position is reached. Unknown to the pilot, his ground track is being altered by wind as indicated by the broken line in the figure. Thus it takes him 2 min. 5 sec. to reach first abeam.

4. Maintaining the same heading, he flies past this abeam before making a left turn to 180 deg.

5. This second boxing heading is held until second abeam is received in 1 min. 35 sec. At this time, by reason of the variations in time required to obtain abeam positions, the pilot is warned that he has a head wind on first boxing heading and may have a head wind on second boxing heading as well.

6. He continues past second abeam for 1 min. 35 sec. and makes a left turn to 90 deg.

7. On this third boxing heading, he finds it takes only 18 sec. to reach third abeam position. This proves existence

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of a strong wind from the west due to the extreme discrepancy between first abeam and Position 4 as compared to Position 6 and third abeam (2 min. 5 sec. versus 18 sec.).

8. The same heading is held for 18 sec. past third abeam position before making a turn to fourth boxing heading of 0 deg.

9. On this heading it is found that fourth abeam is received in 1 min. 35 sec. This establishes position proof that a cross wind exists while flying second and fourth sides of the box, thus confirming that a direct west wind exists.

10. The same heading is maintained past abeam position for 1 min. 35 sec. and again a 90-deg. left turn is made to parallel first boxing heading. At this position the boxing procedure has been completed and the pilot is ready to make his instrument descent to minimum altitude.

### E. Approach Procedure

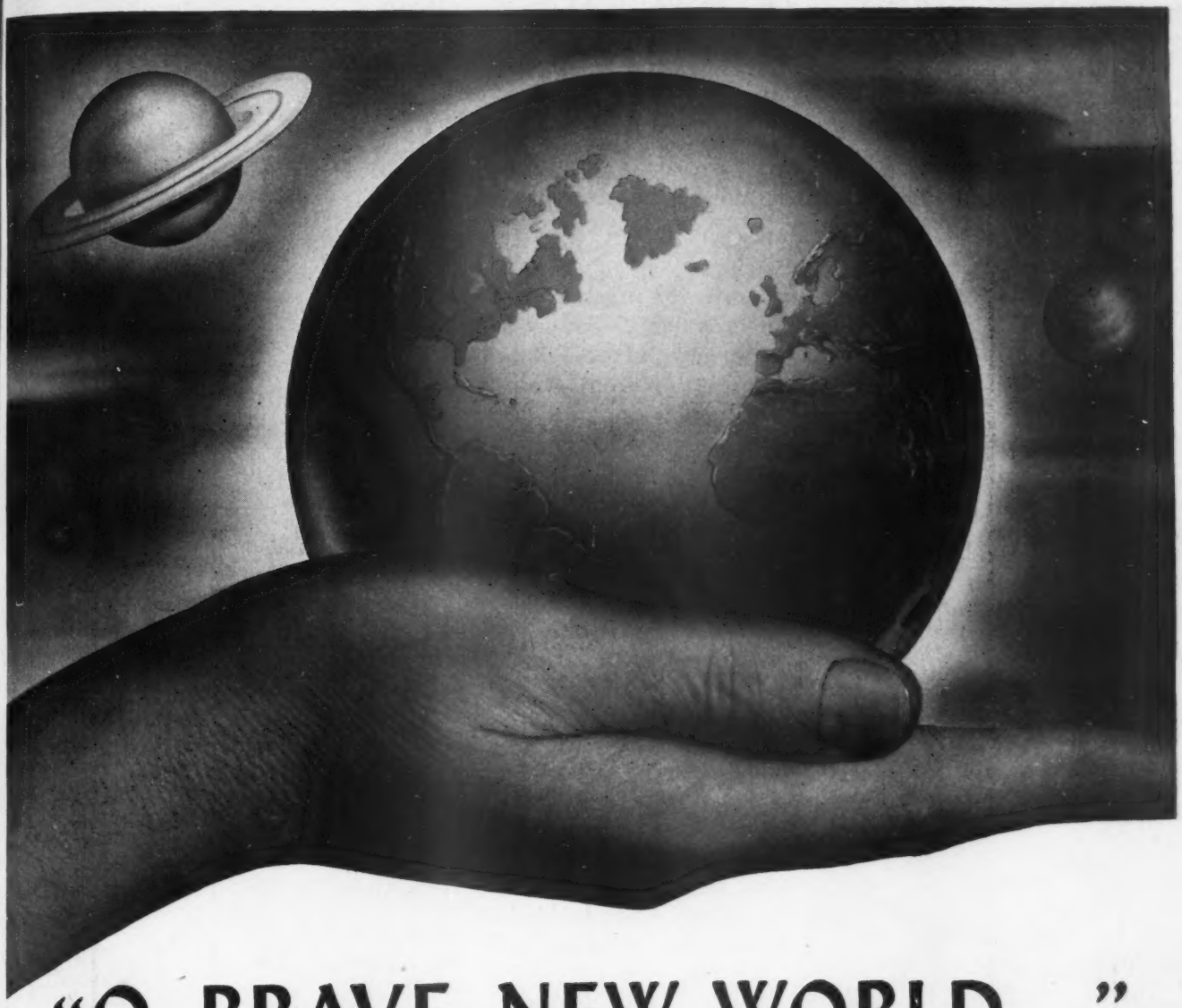
With an approach procedure of which a boxing process is an integral part, the pilot is ready to make his descent to the field at completion of the turn at Position 10 (Refer to Figs. 1 or 2). In our example we will assume that 3,000 ft. has been maintained up to this point. As previously explained, a minimum of 500 ft. is desired over the field. This would be achieved as follows:

1. The same heading used on first boxing leg (the reciprocal of final approach track) will be held until fifth abeam position is received.

2. Continue past fifth abeam position for exactly the same time interval as was previously flown past first abeam position, and make a left turn of 90 deg. in order to parallel heading of second boxing leg. In other words (referring to either Fig. 1 or 2) the time interval between first abeam and Position 4 will be the same as the time interval between fifth abeam and Position 12. This is true regardless of wind.

3. During the time between Positions 10 and 12, the pilot should lose sufficient altitude to reach Position 12 approximately 1,000 ft. above minimum altitude. If, however, due to wind conditions or a high initial approach altitude, he feels this is impracticable, there is no reason why he cannot begin his descent earlier in the boxing procedure. Each problem, of course, must be analyzed individually in this respect.

4. This next heading, which is always at 90 deg. to final approach track, is held for approximately 15 sec. less than was required to reach the second abeam position and thereafter a 90-deg. left turn is made to assume final approach track. At completion of this turn, the airplane should be on final approach track and 2 mi. from the radio station.



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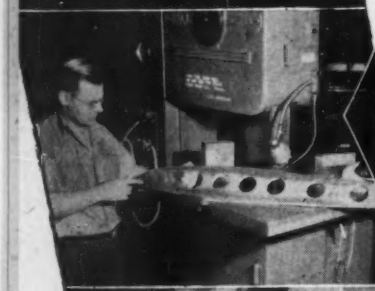
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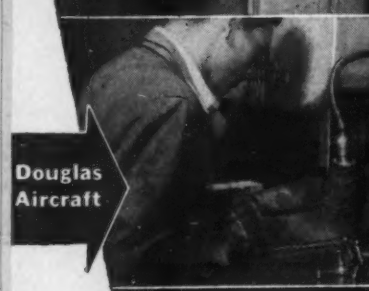
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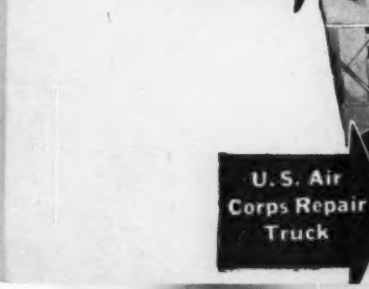
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During time interval between Positions 12 and 13, descent should be continued so that the airplane is approximately 500 ft. above minimum altitude.

An added check that a pilot may make to determine when this final turn should be started is to note when null pointer indicates that the station bears approximately 285 deg. relative. If the turn is started at this moment, radius of turn should place the airplane in desired position.

5. At Position 13, the airplane is on final approach track and is at a known distance from both radio station and field. From this point descent is continued while a normal homing procedure is followed to the radio station. In the short distance of 2 mi., little difficulty should be experienced in maintaining desired track even though wind conditions at the lower altitude differ from those computed on boxing procedure.

6. Due to low altitude at the time the radio station is passed, the safest procedure is to allow the airplane to drift slightly to one side of station in order to prove station passage with an abeam rather than attempting to pass directly over. After passing station, descent is continued to reach minimum altitude by the time the field is reached. If ground contact has not been established at this point, a pull-up should be started immediately.

*Higher wind conditions will be considered by the author in Part II of this presentation to appear in an early issue of* AVIATION.

## Technique of Perspective Projection

(*Continued from page* 197)

*EF* and *HG* (top portion of drawing) into the proportionate parts indicated by points *E*. *Q*, *R*, and *F*. This is done by drawing the sight lines in the top view to these points to obtain the *PP* piercing points *E'*, *Q'*, *R'*, and *F'*. These latter points are then marked off along the paper straight-edge to make the perspective rule for this set of parallel lines of the same length.

The rule may now be laid down in the perspective view in any convenient position, so that its *F'* matches $F^P$, say, and then its points *E'*, *Q'*, and *R'* are marked off along the edge. After joining *E'* and $E^P$, lines from *Q'* and *R'*, ruled parallel to $E'E^P$, will produce the perspective points $Q^P$ and $R^P$.

To divide a vertical line into a desired number of parts, the same principle and construction are used. Obviously, an end view must be used in order to determine the *PP* piercing points of sight lines from $(SP)^R$ to the points on the vertical line, whose perspective is desired.

The perspective scale described above may be used to obtain the perspective of a circle—an ellipse—more quickly than by the point-by-point method, which incidentally is the only method which could be used to obtain the irregular-curve perspectives of the wing cross-section outlines of Fig. 18 (page 174, Apr. AVIATION). A much easier method involves the use of the diagonals, and the axes bisecting the sides, of the square circumscribing the circle, as indicated in the accompanying Fig. 21.

In this same figure, there is also shown an expedient for determining more accurately the location of a *VP* by Method 1. The closer that points *A* and *C* are in the perspective, the greater is the possibility for error in drawing the line to *VP* in *HL* for one-point perspective. By extending the horizontal line from *A* to *C'*, the longer line $A^PC'^P$ is obtained and the direction of the line to *VP* is more accurately determined thereby.

Other expedients of importance exist, but all of them cannot be explained in this brief series of articles on engineering perspective. If the theory of these articles has been mastered, however, any or all of these expedients may be deduced.

Pseudoperspective, as the name implies, is a theoretically incorrect form of perspective projection which, however, is more rapidly obtained, and for certain purposes is just as satisfactory as a true perspective.

Here, *VP*'s are generally assumed, although sometimes they are exactly determined by sketching in the theoretically correct constructions. When the *VP*'s are not properly located by either the exact or inexact methods, the resulting perspective will naturally be distorted. A few basic points can be determined by the exact methods heretofore described, and then the remaining detail can be developed by "artists'" perspective.

This hybrid form has been found quite satisfactory in many of our larger industries. A fine example of an industrial perspective is given by Fig. 22, a drawing of the "exploded" assembly type.

These are extensively used for instruction, both in industry for assembly training and in mechanics' and maintenance courses, to show interrelation of parts. They save much lecture time.

Without the perspective drawings and sketches, production of planes, tanks, ships, and guns will lag. We trust that this series of articles will aid in avoiding such a lag.


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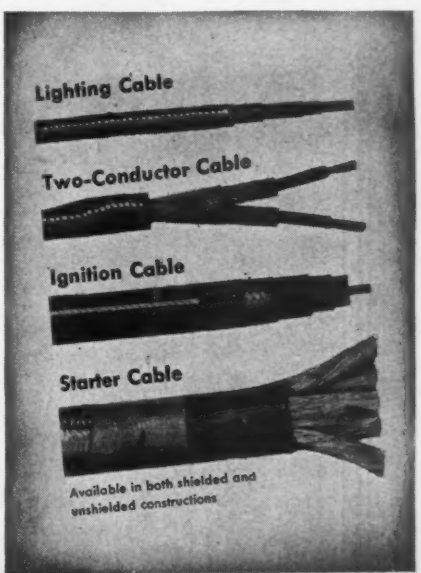


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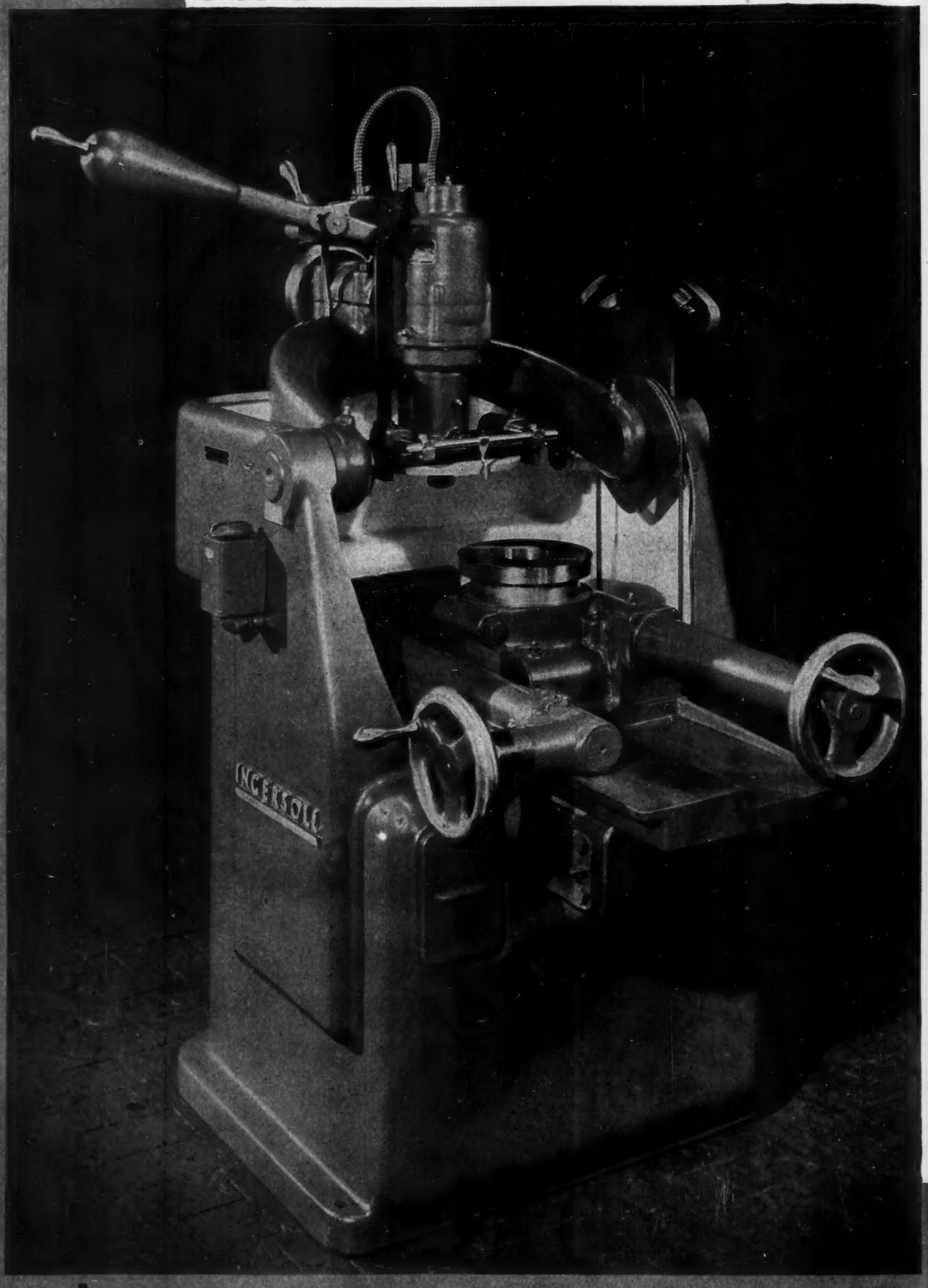


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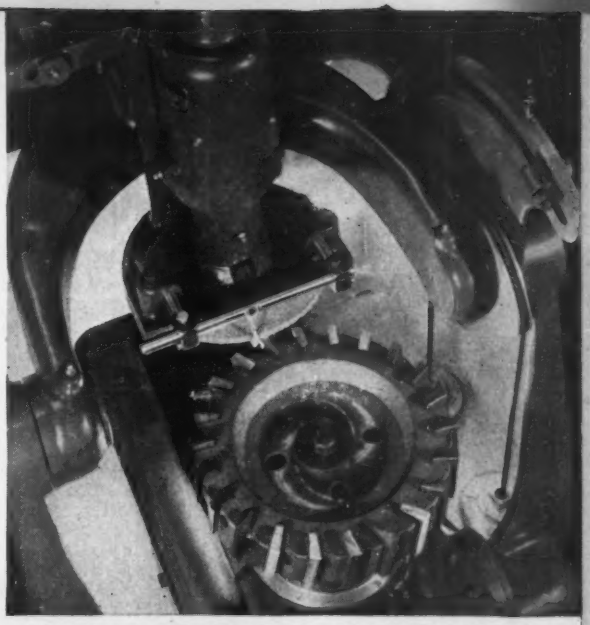

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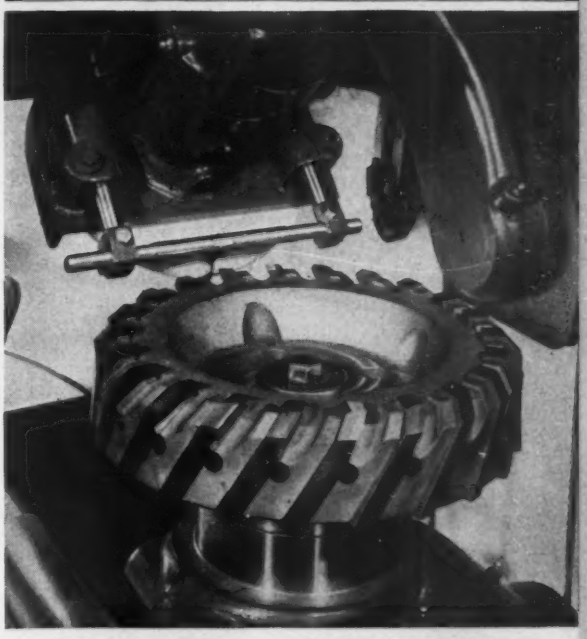

**INGERSOLL SHEAR CLEAR**

**DOUBLE ANGULAR CUTTERS**

# Feeder Airlines Pose Problems

(*Continued from page* 229)

differences provide a starting point for a definition that is specific and might be acceptable:

1. The basic function of the trunk airlines is to provide for the rapid movement of passengers, mail, and property between centers of large population. Feeder airlines should be designated to perform a similar service between centers of small population within an area and between small communities and larger centers of population which usually are terminal points located on the trunk airlines. A glance at an airway map of the United States will show that terminal points of the trunk airlines are located at the concentration points of economic activity for large areas. Such points as St. Louis, Chicago, Boston, and Dallas are centers of large marketing areas. The prime advantage of a feeder airline will be to facilitate a more rapid concentration and dispersion of traffic within the economic orbit of such centers.

2. Feeder airlines will play an important part in the concentration and distribution of goods in the areas they serve. Not only will a feeder airline move traffic from one point to another on its line, but it will gather mail, cargo, and passengers from a large number of small, scattered trading areas and feed this traffic into a few terminal points. The converse of this concentration function will occur when a feeder airline carries traffic from points of concentration—the trunk airline points it serves—and distributes it among smaller scattered communities. Whereas the trunk lines concentrate traffic at a relatively few points, a feeder airline will tend to permit a greater concentration of traffic at one end of the line and a greater dispersion of traffic at the other end.

3. It is apparent that because of the large number of communities that will be served by a feeder airline, the distance between stops will generally be short. Conversely, the distance between terminal points and intermediate stops on a trunk line is considerable since, as a rule, no attempt is made by the trunk lines to serve intermediate points except for refueling or some other requirement beyond the airline's control. This long-haul and short-haul factor makes for a definite cleavage in trunk line and feeder line operations as to the number of stops, size of equipment, capital investment, and other operating considerations.

4. Closely related to the length of haul is the frequency of stops at points served. While the factors dictating the number of scheduled flights between terminal points on a trunk line may change in the future, they have for some time been dictated first, by the postal requirements of the largest point served; second, by the volume of traffic originating at the terminal points; and third, by the necessity of making connections with other trunk line operators. The extent to which a feeder airline will be governed by any one or all of these factors cannot be stated now, but more than likely feeder airline schedules for some time to come will not exceed the minimum scheduled mail flights required for a given route. In order to feed traffic into terminal points, coincident with trunk line schedules, the area which can be served by any one feeder route is limited by the time required to serve the scheduled stops, at that point, of the trunk lines serving it.

5. It is well nigh axiomatic that feeder lines will use smaller planes because of the schedule of stops at intermediate points, or feeder airline sta-


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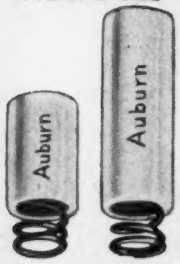


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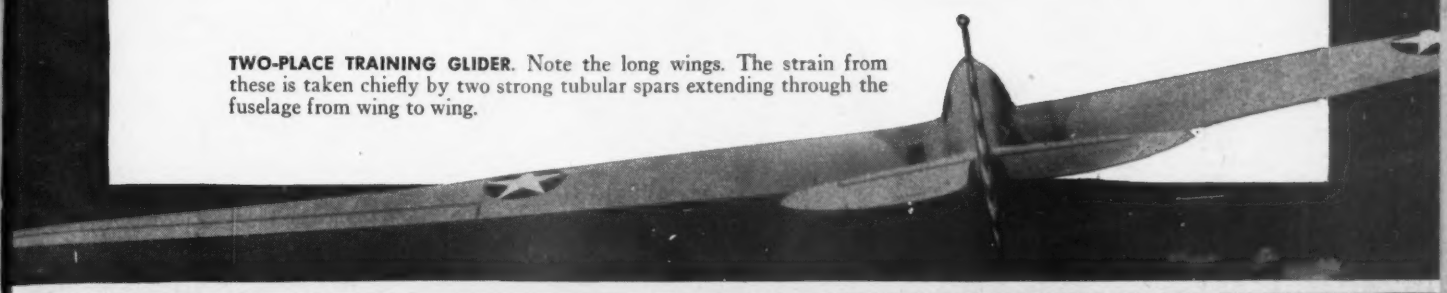

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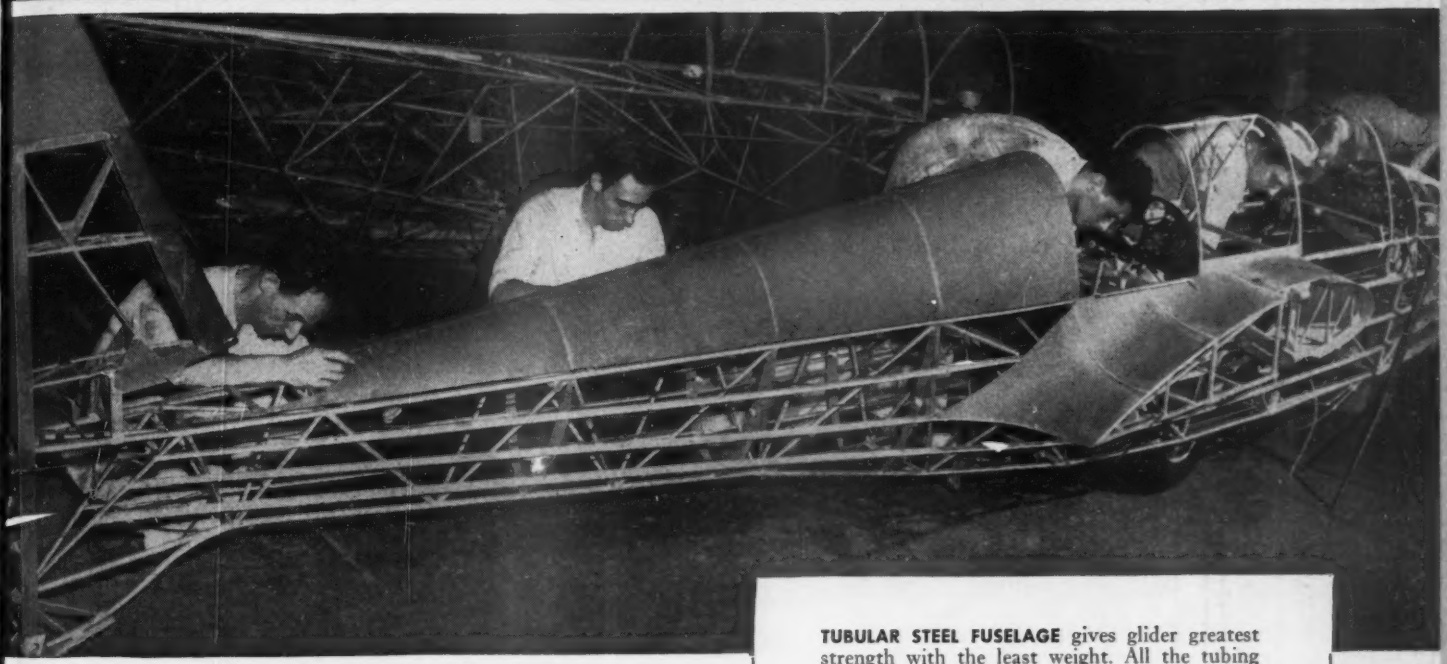

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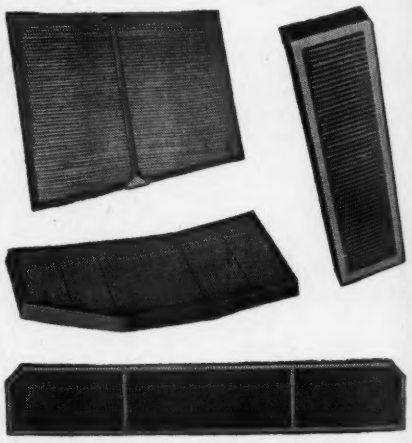

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tions short distances apart, and the type of airports at these smaller towns. The factor of carrying-capacity alone prevents economical use of the smaller planes for regular trunk line service.

6. Feeder airlines will probably have higher operating cost per revenue mile flown, due to short-haul operations, but fixed costs should be lower than those of the trunk lines due to smaller and less elaborate equipment and company organizations.

With the foregoing comparison of some of the characteristics of feeder and trunk line services in mind it can then be concluded that: A feeder airline is (1) a common carrier, (2) which performs the dual function of concentrating and dispersing mail, passengers and/or property, (3) within a given marketing area, (4) from widely scattered points, (5) to a few terminal points.

This definition purposely avoids limiting the scope of feeder airline operations by any preconceived notion as to what shall be the size of the area served; whether a community is or is not at present served by an airline, or if the distance between stops shall be a certain number of miles. It would seem that these are matters of operating policy and should be determined principally by the economic factors governing each case, instead of by definition.

After it is decided just what is, or is not, a feeder airline operation, the type of services to be rendered must be considered. Two major considerations will doubtless govern here. First are the kind and volume of traffic which may be developed. The second, in a large measure dependent upon the first, is the adequacy of airports and landing facilities at the points proposed to be served. Along any feeder route there will be towns with airports, plus other towns which, because the total volume of business originating there has been, and still is, very small, would not justify the construction of an airport and other facilities.

Two types of feeder airline services may be provided to meet the special problems imposed by the different conditions existing among a large number of communities. These are:

**1. Pick-up and delivery.** This type of service would be rendered (as it has been by All American Aviation) primarily to serve towns too small to warrant the construction of an airport.

**2. Standard operations.** This type would provide complete transportation services for airmail, passengers, and cargo at towns large enough and with a sufficient volume of business activity to support an adequate airport and facilities.

With the development of feeder airlines it is highly possible that the volume of traffic which will move over them will reach the point where single planes will be used to offer specific services. For example, if all first class mail were carried by air, pick-up and delivery service may be used exclusively to serve small towns. Over many routes the volume of mail received and delivered would be large enough to insure the optimum utilization of the small planes used in this type of operation. In the same manner special planes might be used on some routes to carry cargo only, while passengers would be carried in craft suitable for transportation of passengers, mail, and express. The entire problem of the kinds and amount of equipment to be used will, of course, hinge upon the kind and volume of traffic present on each route.

The next problem for solution by the CAB—and some in the industry would place this problem above all others—is determination of who is to be permitted to engage in feeder airline operation. Should new companies be permitted to enter the field of commercial air transportation? Or should expan-

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sion be held the sole prerogative of the existing airlines? By Dec. 15, 1941, most applications for feeder routes had been filed by companies not then operating; but nearly all existing airlines had plans, particularly for development of what they call "their own territory" by various pick-up or feeder operations criss-crossing their entire systems.

One school of thought holds the view that feeder airlines should be operated by the trunk lines. Reasons advanced by proponents are that trunk airlines are better able to finance adequate operations; that this means furnishing and servicing better equipment; and that trunk lines are in a position to integrate schedules giving better service to the traveling and shipping public.

It is not believed that trouble would come from monopolistic situations that might develop, since air transportation is a highly competitive business, with the bulk of competition coming from outside the industry. Air cargo or express service must compete directly with railway express, parcel post, and motor truck operations. Except in isolated cases, competition from outside sources would preclude the probability of exorbitant rates, and airmail rates will continue to be fixed by Federal authority.

Furthermore, since feeder airlines generally operate in an area which is within overnight train distance of major terminals, competition from rail and bus service will furnish sufficient check against high passenger rates, even if such rates were not subject to approval by the CAB.

It is further maintained that more economical and safer operations can be obtained when the maintenance facilities of a major airline are available to service equipment, since a more economic use of personnel, equipment, and supplies can be had. The experience of one airline in international operations with several subsidiaries has been that close cooperation between its subsidiary lines and the major company results in a saving of approximately 30 percent in maintenance costs.

The other school of thought feels that expansion of commercial air transportation in the United States should not be left solely in the hands of present operators. It would be unfortunate, it is felt, for the CAB to adhere strictly to the policy laid down in the Southern Airlines case in Jan., 1941, when it was stated that "the number of air carriers now operating appears sufficient." New companies rendering the different types of service contemplated by feeder airlines should be permitted to come into existence. This is the most important field left for expansion of commercial air transportation and it should not be closed to newcomers. The interpretation of the "fit, willing, and able" requirement of the Act of 1938 should be liberalized to permit a company with no more than a skeleton organization to obtain a certificate.

Strict adherence by the board to its attitude, as expressed toward new airline operators in the past, would prevent any such company obtaining a certificate of convenience and necessity in the future. This would be so since the ultimate operation of a proposed route and the need for more than a skeleton organization would depend on a company obtaining a certificate of convenience and necessity from the board. In fact, the actual financing of a new company depends entirely, at times, on the granting of a certificate. The risk would be too great to set up an airline—even a feeder line—with a full complement of personnel and equipment prior to the granting of the right to operate a proposed route.

Another problem that will have to be solved by the CAB very early in the game of feeder airline hearings is what sort of proof of convenience and necessity is going to be required and what

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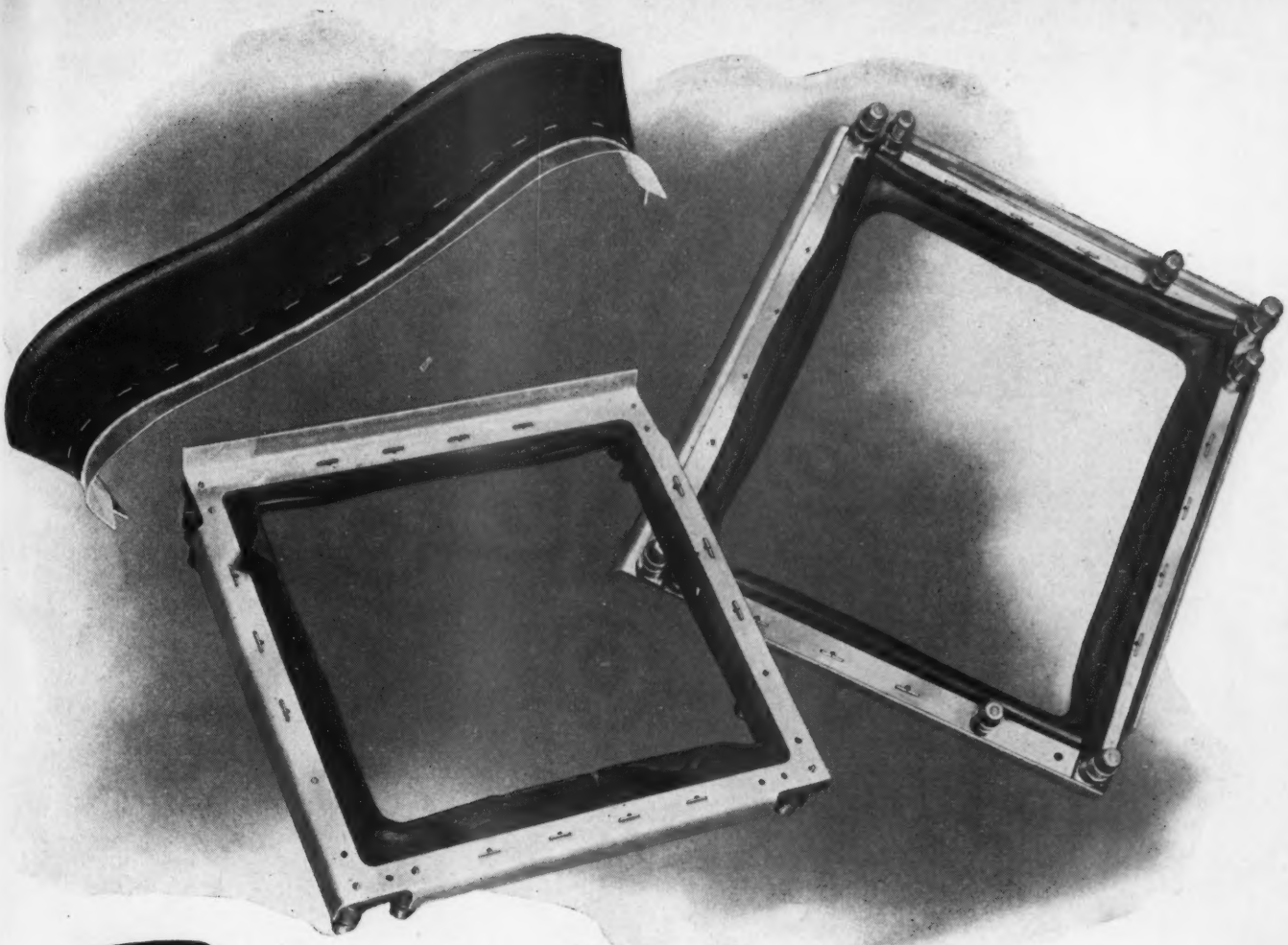

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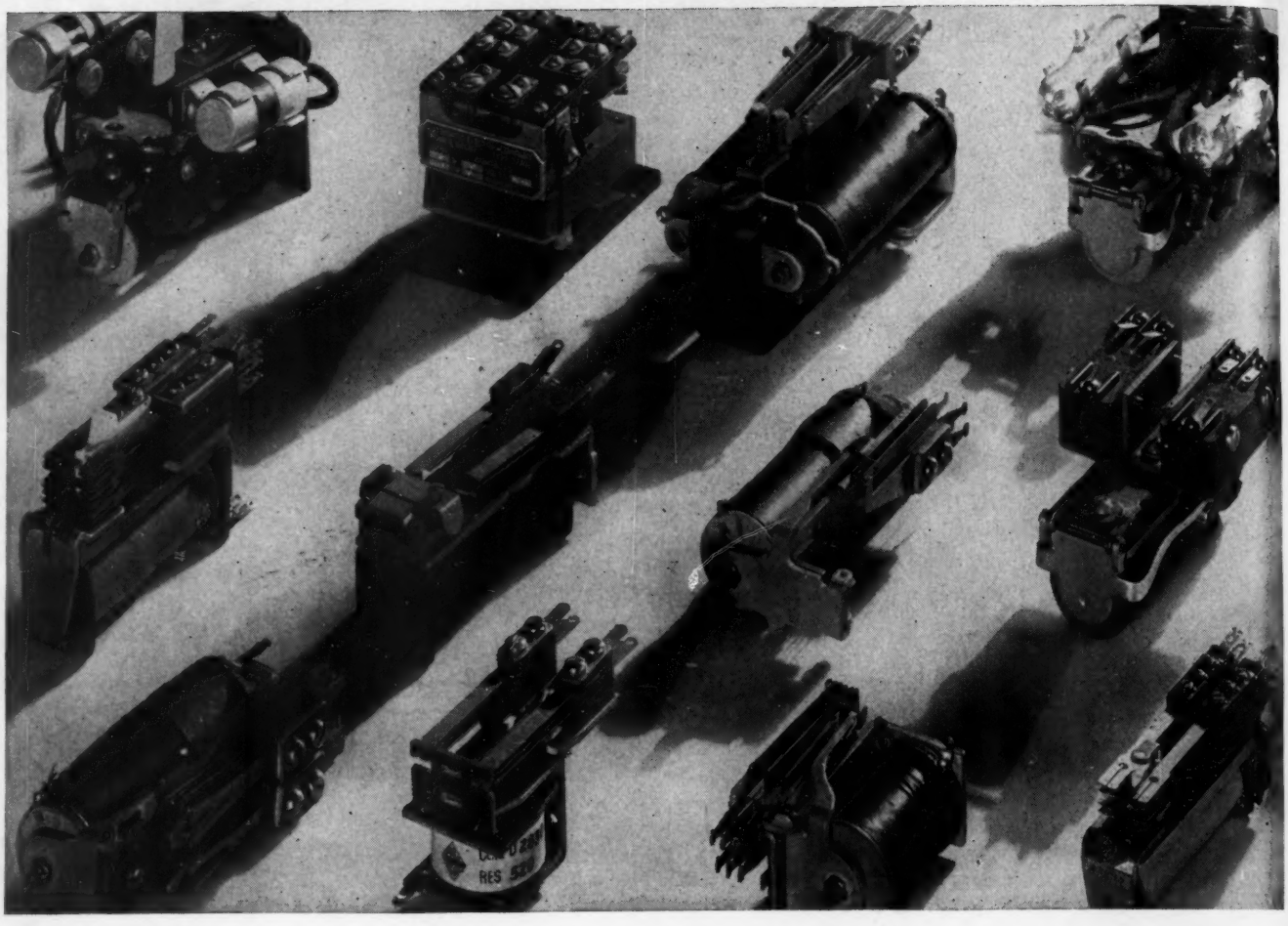

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sort of hearings will be held. Will hearings be patterned after those held on trunk-line applications for new routes or extensions, or will a new procedure be set up to simplify matters and hasten decisions?

The latter would appear to be necessary if feeder airline hearings are not to drag on for years. One way would be to call in all feeder line applicants for a conference to see who is ready for hearing, what kind of case they have prepared, and possibly to establish some form of policy on procedure to be followed in the numerous instances where two or more applicants are requesting the same stops. If this is not done, the voluminous duplication involved might easily lead to a triple proof of convenience and necessity over certain routes, something which can be avoided by proper planning.

In the exercise and performance of its powers and duties, the CAB is charged with responsibility for "the encouragement and development of an air transportation system properly adapted to the present and future needs of the foreign and domestic commerce of the United States, of the Postal Service, and of national defense." Extensions to airlines in operation when the Civil Aeronautics Act of 1938 was passed have been permitted from time to time, but it appears that the actions of the board in certifying new routes has been in response to an existing need rather than a prospective future need.

Under present governmental regulation and administration, new routes must in a large measure be able to pay their own way before a certificate of convenience and necessity to operate will be granted. Airlines are not permitted to face the financial risk involved in the exploitation and development of new routes. Neither is this field open to new companies, however willing and ambitious they are to risk their capital in such an enterprise. Whether intentional or not, past decisions of the Board with reference to applications filed by new companies, indicate an attitude of over-caution and restraint in allowing such organizations to enter into the commercial air transportation field.

It appears that the first prerequisite for inauguration of feeder airline services is a change of attitude by the board so that it will appear sympathetic to that kind of air transport program. To obstruct such inauguration of feeder airlines on the ground that we have enough air carriers or because air transport facilities must be restricted to stations that can pay their own way is tantamount to regression. It repudiates the status of air transportation as a public utility and denies that our technology is to be used in the interests of the nation as a whole.

No one wants an uneconomic development of air transportation agencies in any way parallelling the hasty and unwise railroad construction of the latter part of the last century. Such a situation should be avoided in air transportation. But there are occasions when feeder airline service to a community would promote its business interests through faster transportation and communication and would enable it to compete on a more equal basis with other towns already supplied with direct air service. Moreover, there are those who, with a broader understanding of the social and economic implications of air transportation, approach the problem of an expanded system from the point of view of what it would mean to the nation as a whole. They think of air transportation in terms of creating additional leisure, as contributing to speedier and more efficient methods of distribution, and the manner in which it could add to the total wealth and welfare, not only to a particular community but the nation as a whole.

Feeder airline applications should not be judged in the light of trunk line operating requirements which are fre-

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quently quite different from the requirements for feeder air services. So long as they are so judged the orderly feeder development is improbable.

Air transportation is no longer a novelty to the American people and it is to be expected that as they become more familiar with the advantages afforded by it, the pressure for the expansion of air transport facilities will come not alone from the large cities, but from the smaller communities not now served. It is hardly likely that we can have a continued vertical expansion of air transportation through the increase of scheduled flights between the cities now served without also broadening considerably the base of air transportation through horizontal expansion. This means feeder air lines.

## America at War—Communique No. 17

(*Continued from page* 111)

Besides weakening the Nazi war machine, our Continent air attack is helping the Allies in Africa; it keeps a large chunk of German aviation in Europe trying to fight off the Americans and the British, with the result that the Allies easily maintain superiority in the air over Africa. In the same way, the Allied air war against Europe is helping the Russians.

The Germans will have great problems on their hands when the invasion hour comes. They do not know, of course, where it is coming, so they are forced to prepare air bases and fuel supplies all the way around Europe from Greece to Norway. They feel sure they will be hit on the shores of France, but they don't know in how many other places. They will have to maintain patrol forces, and some reserves, all along these thousands of coast miles, and they will have to keep up some semblance of air war against the Russians. On the other hand, the Allies are, and will continue to be, heavily concentrated at points of their own choosing, for they no longer fear counter-attacks outside of Europe.

Gen. Eaker goes so far as to say that our forces will be heavy enough by midsummer so that we shall not even care whether the Germans know *when* we are coming or not. And in that connection, you can expect more real news from now on. You will likely be told more of how many and what size machine guns a given airplane has; and you will probably learn more about airplane types and changes. The object of secrecy is to keep the enemy from learning of our equipment and our plans. But when he is so weakened or so on the defensive that he cannot do anything about it, even if he does know, then there's more good than harm in telling him.

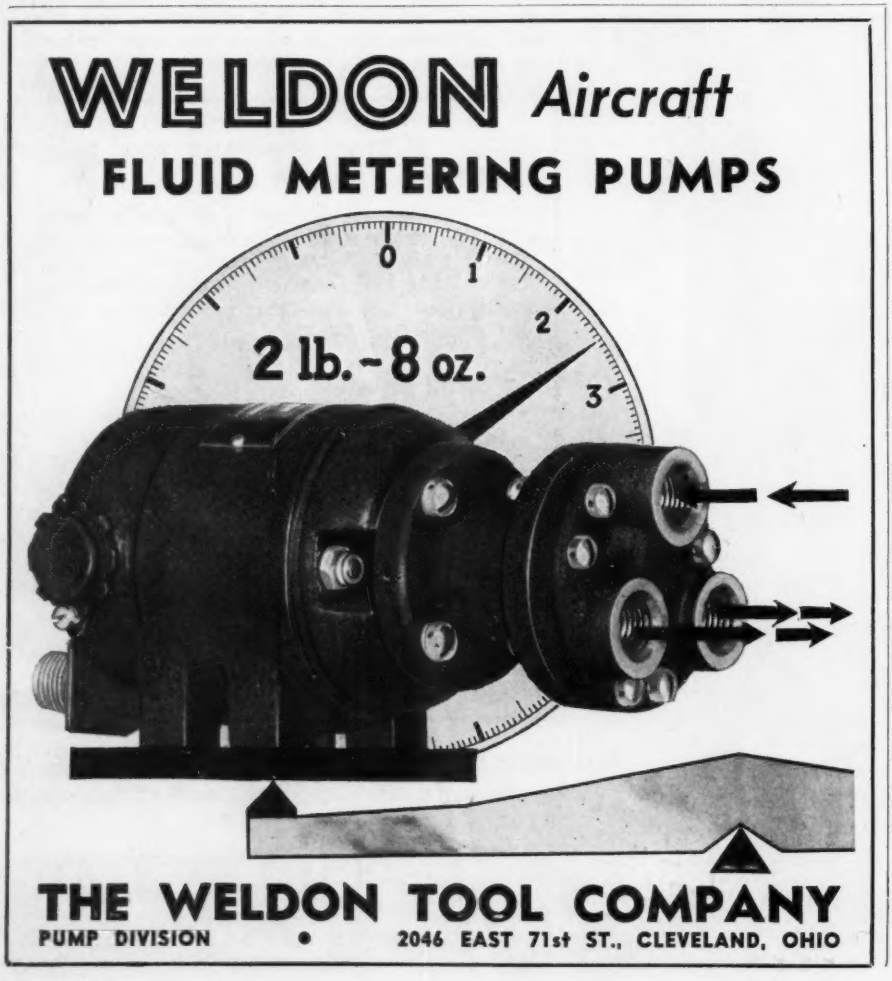
For months now, the United States has been in transition from the ground-holding, time-gaining, planning stage to the offensive stage we are now entering. We are stepping alongside of the veteran Russians and the British to throw some telling punches.

In the air, we have completed the experiment of day bombing over Germany and it is now an institution, with losses not greater than those of the RAF's night losses. We are stepping up our training of United States Air Forces night crews, however, and the British are increasing their training of day crews. The object is to have top-notch Allied day and night hitting power —plus still more when the occasion demands.

We are getting enough airplanes, together with the British, so that before long we can fly a continuous merry-go-round aerial convoy over the Atlantic ship supply lanes. This will help to offset the submarine warfare which Hitler will press with all his might this summer. The quiet waters of summer on the Atlantic are far better than the turbulent winter seas for torpedo work. Ably assisting the merry-go-round convoy will be the Navy's blimps which now have moved into new offshore bases. Previously they had to sail as much as 3,000 mi. out and back when plying their submarine hunting grounds.

In the Pacific, we are still holding ground and planning. Despite the brilliant successes our forces have had in the southwest, we have not regained more than a handfull of the soil Japan seized. The bulk of our forces, particularly our airplanes, are going over the Atlantic to attack the bleary-eyed Hitler, who is the he-devil of the Axis.

Military authorities do not really take the Japanese empire seriously. True, it is a serious nuisance, because Britain and the United States are both punching at the Nipponese with their left hands only. Japan's aviation, you may be sure, is inferior, regardless of occasional rally talks by military and other officials. The Jap navy has been whittled down to something less than our own. Her industrial plant is not capable of processing the wealth of materials taken by force of arms. But Japan is strong in terms of positions gained during the initial weak period of the Allies. By sea, Japan is still 2,000 mi. beyond our reach. Of course, we could bomb the Nips from certain



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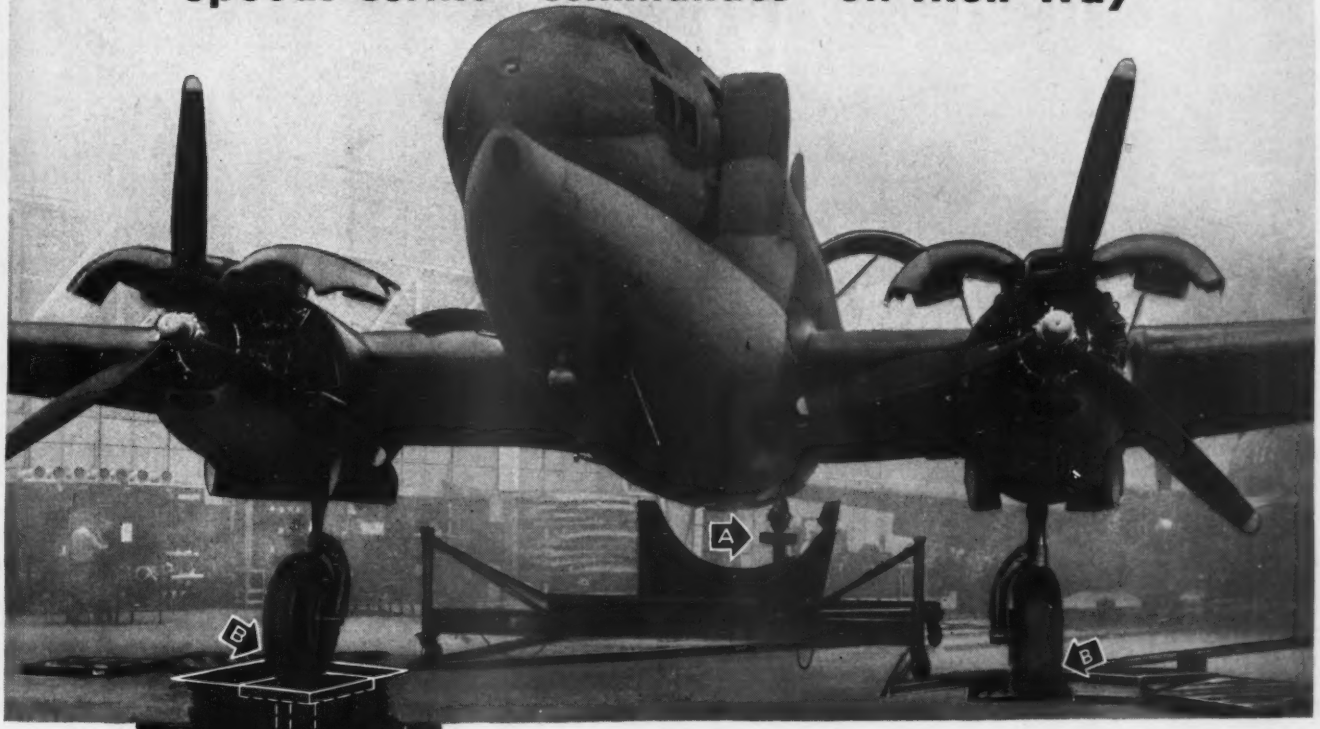
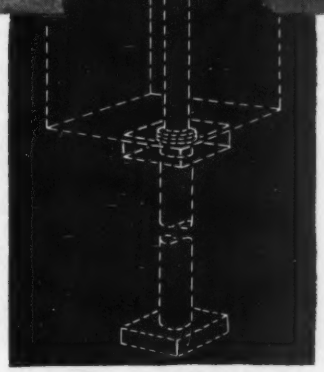
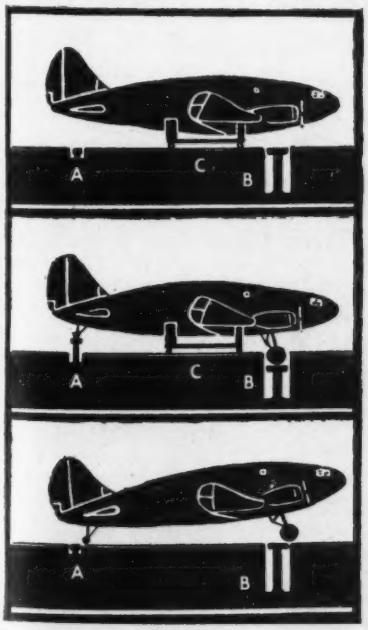


### Plane Lifted from Assembly Line Cradle




**1** The airplane, supported by cradle "C", is spotted over two forward Globe Hoist Platforms "B" and rear tail wheel platform "A".

**2** Platforms "B" are lowered into their pits to permit extension of landing wheels. Platform "A" is raised to contact tail wheel.

**3** Platforms "B" are raised to flush floor level. Cradle is removed. Plane moves away on own landing wheels.

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OUR long experience in this highly specialized field is recognized throughout the aircraft and allied industries.

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positions in China, if we had the bombers and necessary ground services there.

There are so many speculative ways of tackling Japan, once we have finished the Nazis, that there is little use of wasting words on them. Gen. Delos C. Emmons, commander of the department of Hawaii, Gen. George C. Kenney, commander of Allied air forces in the southwest Pacific, and their staffs, under the direction of the President and MacArthur, have held a conference in Washington. They were planning the war on Japan, much as the President and Mr. Churchill planned war on Europe at Casablanca. Maybe they know just what they are going to do, and maybe they don't. You might get a surprise, like the invasion of Africa. For example, suppose the Russians had agreed to attack Japan as soon as they can get the Germans off their backs—so that we could bomb Japan from there.

Our present war of attrition against Japan's shipping is the only major hurt we are inflicting upon the little people. They are playing on their home field, while we are 6,000 mi. from home. We have the moxie to wade into them, but we still have to bring up all the required "makings."

It was said on good authority some weeks back that our airplanes and surface ships and submarines had sunk one quarter of Japan's total shipping, which would seem to be a crippling blow. But then came the news that Japan had seized far more shipping during her conquests than we have sunk altogether. It looks as if the "sons of heaven" will have to wait a while for their licking.

### Home Front Notes

Here at home, we have the Army Air Forces under reorganization so that Washington can dictate general policy. And accordingly, commanders at the front will exercise more authority and initiative. In other words, the Washington high command will tell the front *what* to do, but the front will decide *how* to do it. This change indicates nothing particularly wrong. It simply means that our air forces are on the offensive. They are moving around. When they see an opportunity to hit the enemy, as they will more frequently, they don't want to waste time sending a cable to Washington about it.

Next in importance at home, perhaps, is the Civil Aeronautics Authority's survey of the potentialities of the airmail pickup system. Everybody knows about the du Pont All American Aviation pick-up-and-drop development, which has been a big success.

As soon as the war ends, we will want a market for planes and jobs for pilots. The public wants overnight airmail to all parts of the country, and it wants

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★ Achieve metallurgically and chemically clean aluminum and aluminum alloy parts of engines by using these faster acting, positive, MacDermid, compounds developed for "all out" aviation production.
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Let us help you speed up and improve your cleaning cycle. . . . A qualified MacDermid service engineer, located in one of the cities listed beneath our signature, will be pleased to show you the special Aero compound developed for your particular problem! Free Data Sheets mailed on request.
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Philadelphia

# Bur-Tex ..

## Rides the Jeeps

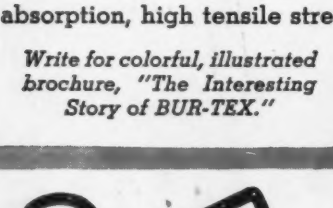
**New Impregnated Felt Fabrics Solve Many Wartime Material Problems**

**GASKETS for jeeps constitute only one of many BUR-TEX applications in today's fighting machines. Specific types of BUR-TEX are being used successfully to replace rubber materials—gaskets, shims, seals, sheet rubber and rubber matting.**

**And because the complete BUR-TEX "200" Line has exceptional vibration dampening, sound deadening and insulating qualities, these impregnated felts are not only giving outstanding performance in tanks, planes and other wartime equipment—but are destined for an important role in many new post-war applications.**

**Engineers, designers and manufacturers are invited to learn about BUR-TEX impregnated felts and their complete list of features including high abrasive surface resistance, low water absorption, high tensile strength, and tear resistance.**

***Write for colorful, illustrated brochure, "The Interesting Story of BUR-TEX."***



**BURLINGTON MILLS**
**INCORPORATED**
BURLINGTON · WISCONSIN


air cargo. The hook-on-and-drop system appears slated to be the feeder system, with hundreds of airline fingers reaching into the towns and hamlets. Inevitably, the direct lift machines will come into this service. The pickup service will take care of the mail, and much of the express, but probably not the small town passengers. (If you want to get your name in the paper, persuade Mr. du Pont to pick you up by air hook.—Ed.) For passengers the helicopters and the autogiros will come in. They don't need airports or hooks. There will probably be gliders in the new feeder system, too.

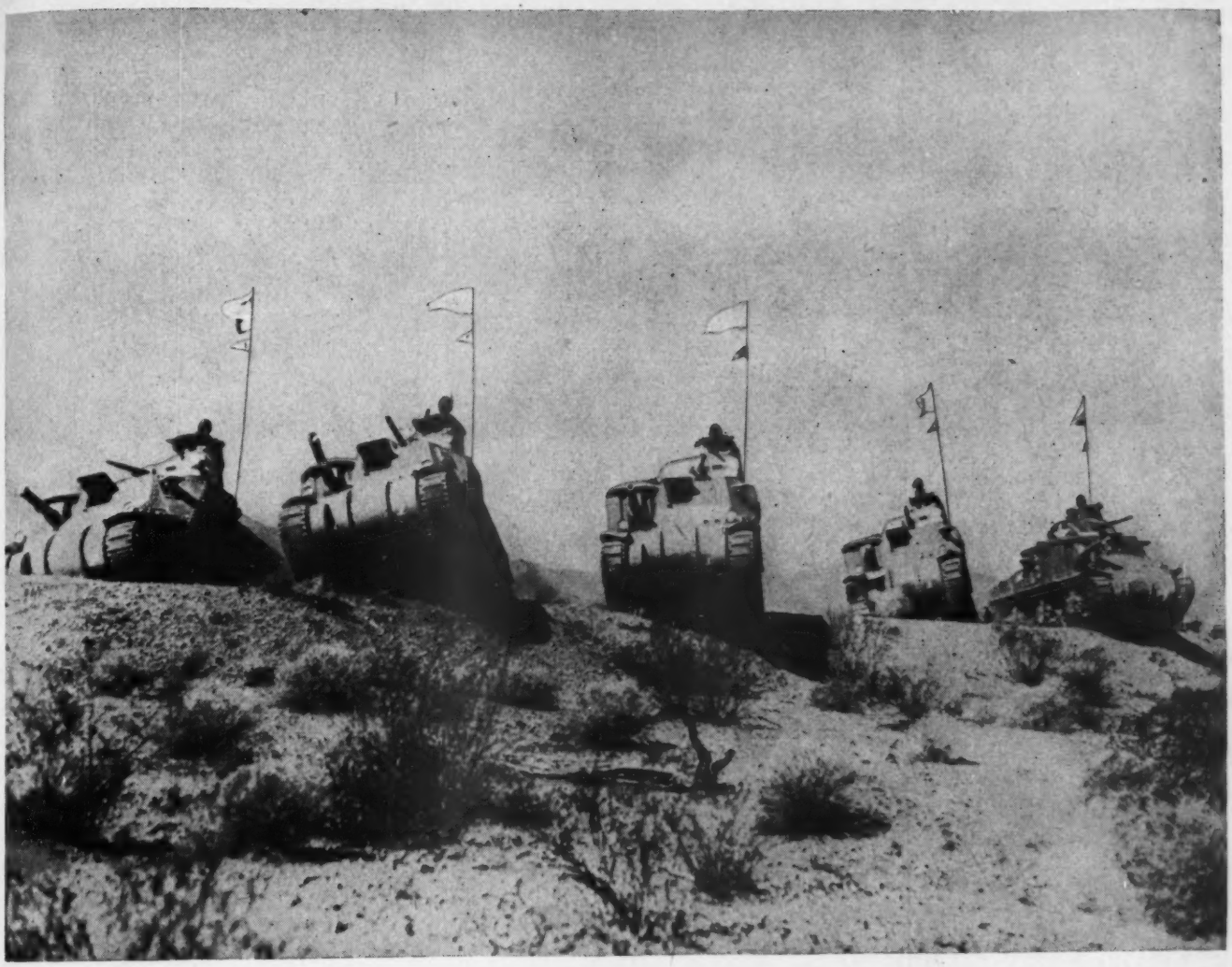
And that man is here again—Mr. Kaiser. He became chairman of the board of the Brewster Aeronautical Corp., by agreement with the Navy, and his announced intention is to bring Brewster production up from a low level to equal the very top. People can argue all they want to about the merits and shortcomings of the famous shipbuilder, but nobody can deny that a man who will tackle a job like that in plain public view, with nothing to gain and his reputation to lose, is a mighty game sport. Kaiser gets no pay, no stock, and no bonuses. He had already purchased the Fleetwings company, and he still is pushing his three experimental heavy planes for the Army on the West Coast.

Meanwhile, a tug of war several years old was brought to an end the other day when the Civil Aeronautics Board gave Pan American Airways a certificate to operate a route from New Orleans right across the Gulf to Guatemala City, a shortcut from the mid-United States to the Canal Zone and South America. American Export had been contesting PAA for the job, but it was turned down because PAA already had the equipment and would need to do very little pioneering to start the service.

But—and this is a big but— the PAA certificate is a temporary one, for three years only. Presumably, with the war over, the whole business of foreign air services will be reshuffled.

### All Aboard for Moscow

The surprise of the month—some people called it a prank—was Northeast Airlines' application to the board for a certificate to operate from Boston to Moscow, and other European cities. So far as could be learned, no one had even asked Mr. Joe Stalin about it. North*west* Airlines, not to be outdone, applied for a line via Alaska to Calcutta. Board personnel said they expected other lines would apply, now that the gun has been jumped. But nobody can beat Northwest on this one —for it would be difficult to find any place on earth any farther from that line's home grounds than Calcutta.



# *To a Tank-boiling is cool*

## ...another job for HYCAR SYNTHETIC RUBBER

ENGINES of the type that power some of our tanks—and may power your post-war car—normally run at temperatures far above the boiling point of water . . . temperatures that would ruin ordinary rubber coolant hose.

Add the fact that anti-freeze solutions used as coolants in these engines contain rust inhibitors that attack rubber . . . and you have two big reasons why they are equipped with coolant hose of oil-resistant, heat-resistant Hycar synthetic rubber.

This is another case where the special advantages of Hycar make possible a rubber product that does things rubber never could do before. From such developments come new ideas, new products, new markets, new jobs.

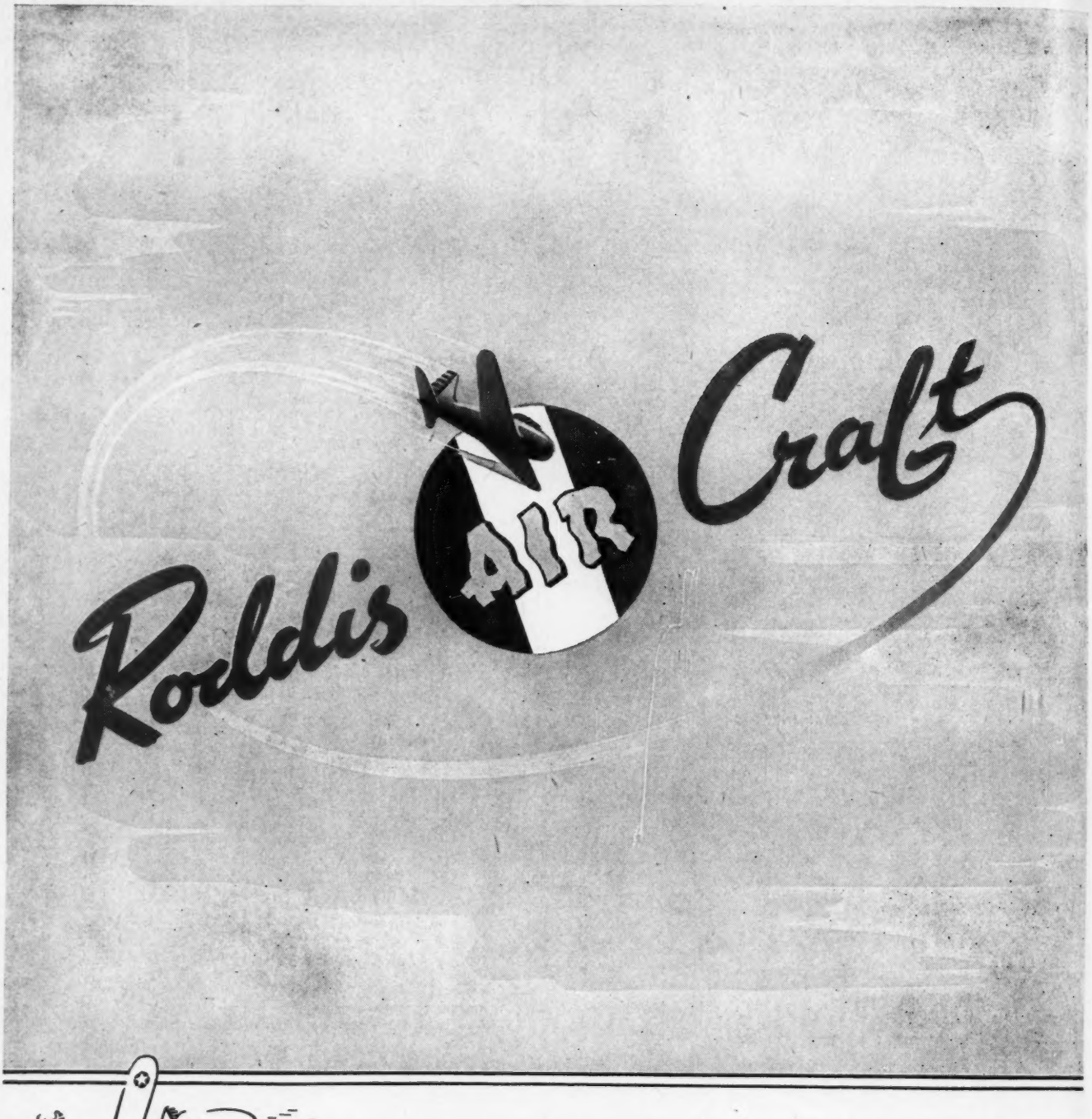
Perhaps your *own* need is for this same type of heat and oil-resistant rubber. Perhaps you need abrasion resistance, or resistance to extreme cold. Maybe you want high electrical resistance, hardness, softness, or some entirely special quality.

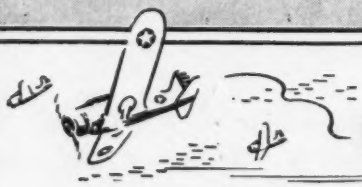
Whatever your need, Hycar, with its years of pioneer development behind it, *and its performance proven in the field,* is your headquarters for all products and problems in synthetic rubber.

*Hycar is made in several types, supplied to fabricators in the form of crude synthetic rubber. We will be glad to work with you and your rubber products supplier in applying Hycar to your problems.*

**HYCAR CHEMICAL COMPANY**
AKRON, OHIO

LARGEST INDEPENDENT PRODUCER OF BUTADIENE SYNTHETIC RUBBER IN AMERICA



## PLYWOOD FOR PLANES AND GLIDERS

To U. S. Army and Navy designers of fighting planes, the name Roddis has been identified with the development of aeronautical plywood for more than 25 years. In 1914 the Roddis organization first began experiments to perfect a plywood combining immunity to weather, and the strength to meet the violent surges of pressure experienced by planes in twisting, turning, diving flight. . . .

Today's Roddis aircraft plywood, being produced on a 24-hour schedule, is practically impervious to soaking in boiling water . . . to freezing or heat . . . and exceeds in sheer strength the rigid specifications of the United States Army and Navy. Made from carefully graded logs and veneers—selected as the finest available for aeronautical use—and bonded by Roddis' craftsmen using the most modern materials, methods and equipment . . . it guarantees to American men with wings, aircraft plywood with the strength and ruggedness to match their fighting spirit.

***See your nearest Roddis representative.***

**RODDIS LUMBER & VENEER CO.**
MARSHFIELD, WISCONSIN

## Opposite Propeller Rotation

(*Continued from page* 161)

propellers, the compensation between torque and offset will allow our boat to keep easily a straight course on the water on one engine only, giving the possibility, for example, of making a buoy at a very slow speed.

### Conclusions Indicated

From the facts reported above the following conclusions may be drawn:

A. If we decide to sacrifice everything to pure speed, outboard rotating propellers could be the choice, on condition that the tail of the plane be designed accordingly. A poor performance on one engine is to be expected, and it may offset the extra speed.

B. If we want a safe airplane, easy to maneuver even on one engine only (and it seems to us that "safety" is a factor of first importance even in wartime) inboard rotating propellers are indicated.

C. In the particular case of the flying boat, no hesitation seems to be possible. Inboard rotating propellers are the answer, if not already by aerodynamic reasons, at least by hydrodynamic considerations. With those propellers, we will have at the same time a good performance on one engine, which is a highly desirable thing for an ocean-going, twin-engine flying boat, and also a good performance on the water, particularly during the critical period of takeoff.

## Welded Seam Inlet Elbows

(*Continued from page* 199)

tube and is automatically trimmed off just beyond the welding rolls.

From that point, the tube continues through four more sets of rolls which size it accurately. Upon issuing from these rolls, the tube is automatically cut off in lengths required.

As forming, welding, and sizing operations are continuous, the cut-off device is designed to move forward with the tube until the cut is completed, then it is automatically drawn back to make the next cut. Normally the machine is operated by two men, one of whom tends the feeding end while the other removes the lengths of tube as they are cut off, placing them in tote boxes for transfer to locations of succeeding operations. A spot welder, between the stock-feeding reel and the machine, is used to join the end of a new strip to the tail end of the preceding one, assuring a continuous feed to the rolls.

Before bending, the lengths of tube are flanged at one end and then are normalized. Bending is done in a standard machine, with weld near the inside of bend, radius of which is formed by the central block which is grooved to fit the tube. As the tube is not filled before bending, there is some tendency toward wrinkling, and the diameter at different points around the bend is likely to vary, making subsequent sizing essential.

This sizing and truing is accomplished in a special die, split vertically and operated by a hydraulic cylinder on the bed of a crank press. This die has a cavity which fits the exterior of the finished elbow, the latter being slightly under size (at least in some parts of its length) when put in place. The press has a ram which, in its first stroke, forces into the elbow a hardened steel sizing ball. Before each succeeding two strokes three chaser balls are fed in and forced down. This pushes the sizing ball through the elbow.

In its passage, the ball irons out any wrinkles and irregularities, sizing the elbow accurately as its walls are forced against the walls of the die cavity. At the end of the third stroke, all seven balls roll out of the elbow into a tray set to catch them. Then the press is stopped, the die opened, and the elbow, now correctly sized, is gaged and removed.

Following this sizing, each tube is clamped in a test fixture and subjected to air pressure under water to make sure that there are no flaws. Then the flange is sheared off and a flat is formed near one end. Next, the elbows are placed in supports on a chain conveyor which carries them through an automatic sand blasting machine. This removes all grease and dirt from both interior and exterior and prepares the outer surface for painting.

The latter operation includes a spray coat of yellow primer and a subsequent coat of black enamel, also sprayed on. Spray booths have water curtains, and the sprayed elbows are suspended from a chain conveyor with ends plugged. When the paint has dried, plugs are removed and the interior is sprayed with oil to prevent rusting in transit to assembly plants.

In service, these welded inlet tubes have proved equal to the seamless type, due to careful manufacture.

# LIGHT FROM FLOORS brings 20% more light

**A light-colored concrete floor** made with Atlas *White* portland cement reflects more light than a floor made with *gray* portland cement and very much more than a floor made with still darker materials. Installations in aircraft plants for Boeing, Consolidated, Douglas and North American prove this. Extensive lighting tests show that a white-cement floor, compared with a gray-cement floor in the same plant—

- ▶ *Provides 20% more light on vertical work surfaces (see illustration);*
- ▶ *Reflects 61% more light to underside work surfaces.*

These increases in illumination sharpen vision, reduce accidents, decrease spoilage, increase production.

Concrete floors made with Atlas *White* portland cement have the same characteristics, including durability, as concrete floors made with gray portland cement. In addition, they are light in color.

Maintenance is simple—frequent sweeping, occasional damp mopping, periodic scrubbing.

Send for new book, "Light from Floors." Write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

AV-F-15

**ATLAS WHITE CEMENT**
For Light-Reflecting Floors


## Heaters for American's Flagships

(*Continued from page* 237)

pletely enclosed between the two grooved parts at the point of stress and so cannot flatten out. A grooved block anchors the stationary end of the tube.

The "U" sections are next fitted into three curved molds (Fig. 2) according to size, and here a similar bending attachment puts a reverse curve in the ends. Then the tubes are set into a cutting jig (Fig. 3), where they are cut to proper length at an angle of 60 deg., which brings the ends flush with plates to which they will be welded.

Next the three sizes of tube sections are fitted in their proper positions in the two header plates, which are held in a sliding jig (Fig. 4). Short sections make up the inmost group, longer ones the intermediate, the longest outside.

The assembly is now ready to be welded. The chief problem here, as will be recognized by welders, is to fasten the plate in a way to prevent buckling and distortion from the one-sided application of heat to the plate. This is accomplished by the jig (Fig. 5) designed by Mr. Davis, which is in two sections fitted over each side of the plate and held by a clamp. It is designed to put a stress on the plate opposite to the welding strain, so that after all tubes are welded to these plates, the jig is removed and heat contraction during cooling straightens the plate to normal.

To make certain that all joints are tight after welding, a box with a rubber seal is clamped over one header plate (Fig. 6), while to the other is fitted a box with an air hose connection, which is clamped over tube ends on a rubber gasket. Air pressure at 60 psi. is applied while the assembly is held under water to check for leaks.

The next step (Fig. 7) is welding the flange and collar for the steam connection. As evidenced in Fig. 9, this whole connection is composed of a sump, made from a metal stamping, with the fitting welded into it. The sump, in turn, is welded to the header plate (Figs. 8 and 9) completing the unit. The water connection, as seen at bottom of Fig. 8, consists of another sump with a $\frac{3}{8}$-in. pipe fitting in the side instead of on top, as is the steam fitting. The shell, shown in Fig. 9, is in two parts, with slots in the longer section which slides into grooves cut in sides of the header plates. The short section fits in the end and is riveted, holding the whole shell tightly to the header plates. The steam fitting is for a $1\frac{1}{2}$-in. pipe.

This boiler is very similar to the original Douglas design, except for the 60-deg. angle of boiler tubes in the header plates. This was modified from the original 90 deg. in order to decrease the stress concentration at that point, which is where the tubes fail first. Arc welding was also introduced, instead of gas, to reduce initial strains set up by the greater amount of heat involved in gas welding.

Tubing used at first was type 321, which is 18 percent chromium and 8 percent nickel, later replaced by type 446, which has no nickel but 24 percent chromium. Having a low expansion coefficient, the latter has given better service. It is a flash-type boiler, controlled by thermostat and a pressure chamber which regulates the flow of water to the tubes. With best quality tubing, the average life is about 700 hr. Die marked tubing or inferior alloys shorten this span.

## Why Not Forged Engine Mounts?

(*Continued from page* 176)

advantages of the welded construction:

1. Tubing used for the welded mount must be first grade, and since preliminary operations are required to produce finished tubing, the price per pound is higher than that for regular stock.

2. Many details are necessary for every assembly, and each detail requires several operations.

3. Highly skilled welders and many jigs are required for mass production.

4. Cooling cracks are the cause of many rejections. Rejected assemblies delay deliveries and keep the prices high.

5. It is very difficult to maintain accuracy, due to distortion while cooling.

6. Finish machine operations after assembly to obtain interchangeability are difficult because of hardness of material at this stage.

7. Stresses allowed for welded tubular construction are only 90- to 95,000 psi.

For the forged mount there are entirely different conditions:

1. Since the material used is to be forged, no previous finishing is needed, consequently the cost of stock is only about one-fifth that of tubing.

2. Only a few pieces are required, with a rough first operation, as compared with tubing subassemblies.

3. After forging only semi-skilled

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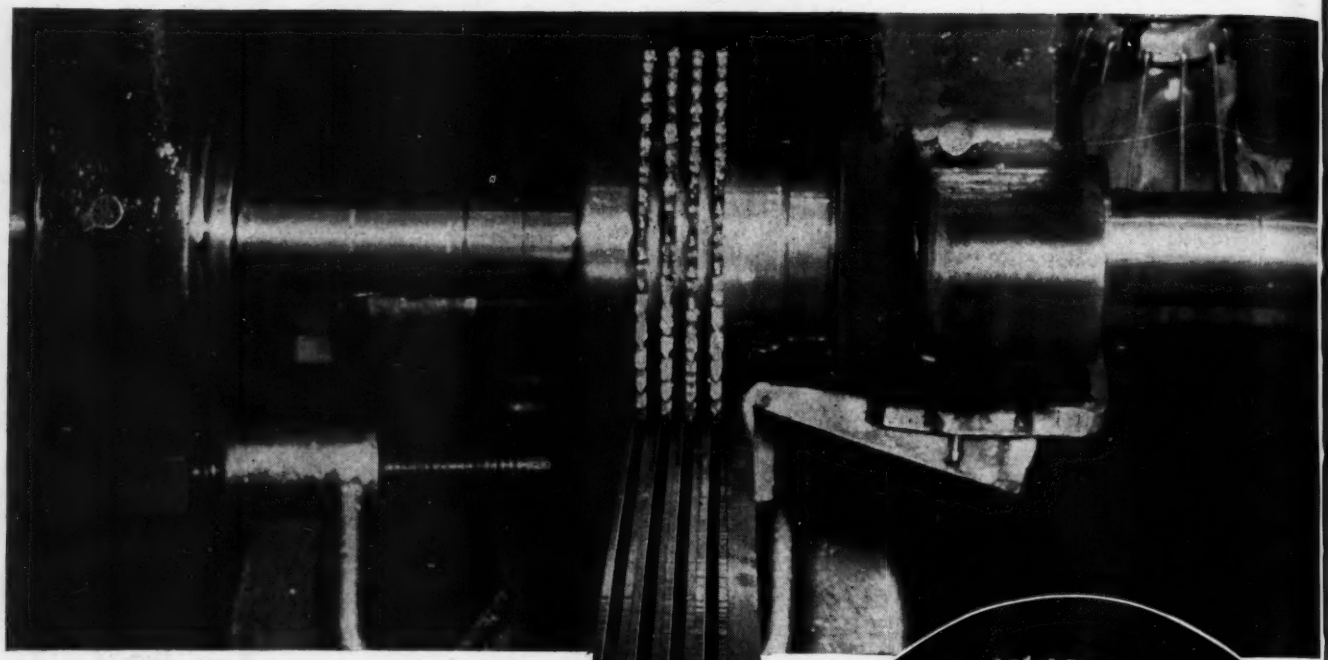
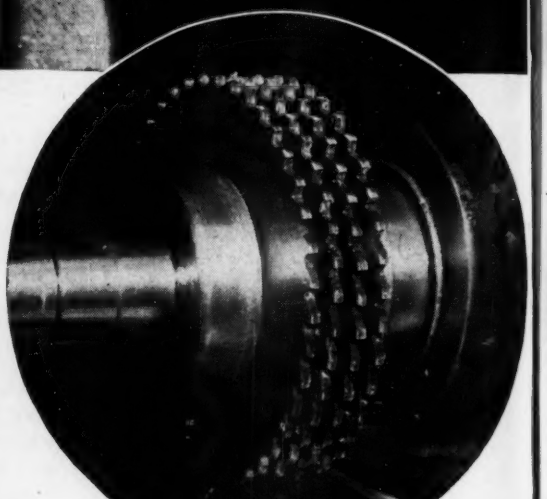
# ATKINS *Curled Chip* SAWS



## Accurate Gang Sawing Speeds Production By Cutting 198" in 8 Hours

Here is an example of high speed, accurate gang sawing you will recognize as way above average. Four Atkins Curled-Chip Milling Saws, operated in a gang as shown, were cutting 3/8-inch deep, 1/8-inch wide slots in steel plates. The saws were 5-inch diameter, operated at 32 RPM spindle speed, 42 RPM peripheral rim speed. The material cut was SAE 1090 22 Rockwell (and that's plenty hard). Yet these saws cut at the rate of 198" in 8 hours—a truly remarkable record, on work requiring utmost cutting accuracy.

Our file of performance data on the great cutting capacity and long cutting life of Atkins Curled-Chip Saws is growing daily. It offers convincing proof that the Atkins Curled-Chip System (including Milling Saws, Segmental Saws, Powersaw Blades and Band Saws) is today's most practical way of getting work out fast and efficiently. Write for these data today.



### More Examples of Accurate High Speed Cutting

- Atkins 28" Segmental Saw credited with startling performance of approximately *7 seconds the cut* on 8" Round Bronze Billets.
- 650% *More Production*—Sawing 40 mm. burr-free shell bands at 1 each second with an 8" Curled-Chip Saw instead of 4 every 30 seconds on a screw machine.
- 860 Brass Slabs, 15½" x 4½", *59,985 sq. in. cut between sharpenings* by Atkins 30" Segmental Saw.
- Atkins 28" Segmental Saw records *27 seconds per cut* on 75 mm. stock.
- *Production 45 Times Faster*—A whirlwind reduction in cutting time on 2½" Electric Cast Steel—7½ minutes to 10 seconds is the achievement of Atkins new 6" Curled-Chip Milling Saw.

**E. C. ATKINS and COMPANY** • **444 S. Illinois St., Indianapolis, Indiana**

machine operators are necessary for the simple machining operations on the fool-proof jigs—an important factor now because women can easily perform these jobs.

4. Use of the new aircraft forging steel X4340 assures good machinability, even at high tensile strengths. Other alloys can be used—many have been developed.

5. Tensile strengths as high as 180- to 200,000 psi. may be used.

6. All parts being jig-drilled, all are interchangeable and easily assembled ~~without~~ highly skilled help.

7. There is great shipping advantage. Assume for example that 30 engine mounts are to be sent to a base in Africa, Alaska, or Australia. Instead of 30 large crates containing the whole assemblies, mounts can be shipped disassembled, requiring less space.

Composition of X4340 SAE steel is as follows:

| | Percent |
|---|---|
| Carbon | 0.40–0.45 |
| Man. | 0.60–0.80 |
| Phos., max. | 0.025 |
| Sul., max. | 0.025 |
| Si. | 0.15–0.30 |
| Nickel | 1.65–2.00 |
| Chrome | 0.70–0.90 |
| Moly. | 0.23–0.30 |

Weight of the mount shown would be considerably less than 100 lb., but taking this as an estimate maximum, each mount would require two pounds of nickel. Thus a four-engine bomber would require eight pounds. One ton of nickel would furnish mounts for 250 four-engine ships, and five tons would be sufficient for 1,250 ships.

## Review of Patents

(*Continued from page* 212)

be made and used by or for the government without royalty.

**Parachute Device** in small container which is shot aloft and which releases flare attached to a small parachute is made of flexible thermoplastic sheet. Unit is formed by using a spherical form to distend a blank sheet, already softened by an electric heater. Resulting sheet is thus of reduced thickness.—2,309,107, filed Oct. 18, '39, issued Jan. 26, '43, G. E. Giroux, assignor to Aerial Products, Inc.

**Radio Guidance System** for causing a plane to follow a predetermined path during any operation which involves a change in altitude. A radiated field with a path of any known shape is picked up by a preadjusted receiver in the plane thus changing the course of the aircraft without affecting the radiated field in any way. Change in altitude and atmospheric pressure is used to adjust the receiver.—2,309,314, filed Dec. 26, '40, issued Jan. 26, '43, J. A. Harshaw, assignor to Washington Institute of Technology, Inc.

**Vertical Speed Indicator** is designed to improve the accuracy of instruments for measuring the rate at which a plane is changing altitude. The device combines a pin hole and capillary tube type of restrictive opening, a chamber or reservoir, a pressure differential responsive means, and an indicator.—2,309,400, filed Jan. 14, '38, issued Jan. 26, '43, P. Kollsman, assignor to Square D Co.

**Propeller Blade Fairing.** An improved shank fairing cuff for a blade with a normally rounded shank. The cuff may be formed of two separate hollow members secured together in operating position upon the blade and held there by fasteners at each end of the shank fairing cuff.—2,309,466, filed Aug. 31, '40, issued Jan. 26, '43, E. Martin, assignor to United Aircraft Corp.

**Rate and Altitude Indicator** employs a vibrating rod or wire secured at one or both ends to give rate and altitude information. Suitable electrical pick-off means are provided.—2,309,853, filed Apr. 10, '41, issued Feb. 2, '43, J. Lyman and E. Norden, assignors to Sperry Gyroscope Co., Inc.

**Aircraft Breathing Regulator,** demand type for supply oxygen, includes a housing in which there is a respiratory chamber connected with the face mask. There are passages through which the chamber is supplied with air from the ambient atmosphere surrounding the regulator and with oxygen from an oxygen chamber. Aneroid-operated valve determines the extent of opening of the passages and, according to the altitude, the relative amounts of air and oxygen that enter the respiratory chamber.—2,310,189, filed Oct. 11, '41, issued Feb. 2, '43, G. M. Deming, assignor to Air Reduction Co., Inc.

**Release Drag for Tow Targets** relates to apparatus for releasing targets towed for anti-aircraft gunnery practice. It may be made and used by or for the government without payment of royalties. Difficulties with long tow cables have been overcome by combining a target release mechanism with the towing cable. A traveler, propelled by the air stream and mounted on the tow cable, slides over the release device freeing the target.—2,310,249, filed May 26, '41, issued Feb. 9, '43, J. J. Maskey.

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HYDRAULIC MOTORS
For driving pumps and for a wide variety of other applications on aircraft, Clarke Aero-Hydraulic Motors are found adaptable because of small dimensions, high power output.
TYPE CO2 (Illustrated)
POWER—Motor develops 1.4 h.p. at 1000 p.s.i. inlet pressure. Weight of only 48 ounces and compact design eliminate needless bulk. DAMAGE-FREE—Stalling causes no damage to motor, permitting use of stops to eliminate flap or door overtravel. DIRECT-REVERSIBLE—no external bleed line required, obviating additional fittings. ADAPTABLE—Available with either flange or foot mounting for all installations. (Foot mounting illustrated)
Design engineers, purchasing agents, and other authorized persons are invited to consult with Clarke engineers concerning hydraulic motors and similar equipment for aircraft.
CLARKE AERO-HYDRAULICS, INC.
PASADENA • CALIFORNIA

## Factors of Contract Renegotiation

(*Continued from page* 121)

obviously are less concerned over the postwar situation than industries that face a somewhat more dubious future. The large automobile manufacturers, for example, entered the war well-heeled financially. Their future is bound up with postwar prosperity. While they are temporarily switched to aircraft manufacture and other munition making, the prospective demand for automobiles grows apace. There has been no tremendous plant expansion in their major field nor have giant companies from other industries entered it for the very obvious reason that pleasure cars are "out" for the duration. The profits this well-established and seasoned industry makes during the war are quite secondary; they know that capacity operations await them after the war and that they will have plenty of working capital to meet all demands.

On the other hand, such industries as aircraft, steel, and machine tools may pass through a number of lean years after the peace. They have been expanded far beyond maximum peacetime needs. The aircraft industry particularly may experience difficulties in getting re-orientated. It has emerged from twentieth place to the largest of all American industries with even steel, the runner-up, now far behind. And in the process its working capital resources have become inadequate in relation to the tasks ahead.

As America's leading wartime industry, the aircraft business may emerge from the war having done all and more than the government asked of it—but with its solvency jeopardized.

Here is what Tom M. Girdler, chairman of Consolidated-Vultee Aircraft Corp., recently had to say about renegotiation to his stockholders:

"In our opinion the emphasis in contract renegotiation should be on how the government is going to get the greatest value for its money. This can best be accomplished by giving proper recognition to low-cost producers.

"This corporation has assumed enormous responsibilities which require capital. The entire capital of stockholders is very properly at risk in the war effort, including the capital added through earnings. But in order to carry on its vast current production and to meet its future responsibilities, Consolidated must remain strong—not only in manpower and machines but also in working capital."

Mr. Girdler believes that victory in this war and the guarantee of peace to follow make it imperative that efficient producers be allowed to retain funds for plane production on a scale adequate to the national needs.

The Truman Senate investigating committee has somewhat similar views. Said that important committee in a report last month on the matter of postwar reserves: "Sound national policy requires encouragement of manufacturers to set-up such reserves, and somewhat more liberal allowances of profit margins might properly be made to contractors who create reasonable reserves of this character than are allowed to contractors who spend or distribute all profits as they are earned."

The biggest argument against recognizing such reserves, according to government officials, is that they give to companies which were able to convert to war production further advantage over those which were compelled to shut down shop.

However, the Truman committee made it plain it did not consider that argument a sufficient barrier against reserve allowances, declaring "it does not aid either the country or the peacetime manufacturer who has been put out of business to put all the wartime manufacturers out of business, too."

Meanwhile, certain officials on the War Production Board and in the Treasury Department are studying proposals to allow companies to set up postwar reserves without being penalized under the renegotiation or tax laws. And, what is more important, the idea is gaining favor on Capital Hill. The powerful Senate Finance Committee is willing to study the Truman committee suggestions on reserves and act on them, if convinced of the reasonableness of the proposal.

This is an outline of official suggestions as they have jelled so far:

Authority should be granted by law for postwar reserves to be treated as appropriate and deductible charges for tax and renegotiation purposes. These purposes would have to be carefully circumscribed.

A company creating such reserves could use funds from these reserves after the war for re-conversion to peacetime production and to make offsetting charges.

If the company used all its reserves for re-establishing itself as a producer of non-war goods, no adjustment would be necessary.

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been allowed before as a deductible reserve.

So much for the case on reserves. Industrialists also regret the government's failure to create a board of review to which disputed decisions of a price adjustment board might be taken on appeal. This lack of such an impartial court of final resort, it is said, is responsible for many of the delays in contract renegotiation.

Early in March the Army and Navy had reached final settlements in less than 2 percent of the total number of contractors which had been assigned to them. The War Department reported that final settlements had been closed in only 140 cases of a total of 7,097 contractors assigned, while the Navy reported 38 final settlements of 2,250 cases.

That is why so few annual reports of aircraft companies were released to stockholders this year with the confident words "Net earnings for 1942 were $——." Tucked somewhere in the statement, in most cases, were such qualifying words as "the uncertainities which arise from contract renegotiation make the corporation's earnings subject to possible change." These changes can, and probably will, amount to several million dollars of the profits accredited to stockholders in the various reports.

Another source of dissatisfaction with renegotiation has been the lack of definite standards in its administration. As mentioned before there are four price adjustment boards representing the different war service arms, and they all have different methods of procedure. The contractor is assigned to the board that has the predominate interest in his war production.

The Truman committee specifically urged in its report the unification of price adjustment boards. Spurred on by the committee, the boards issued a joint statement of uniform policies which clarified somewhat the confusion that has surrounded renegotiation administration on a number of points.

But the complaint still is heard that each individual supplier of the government may be treated differently from every other supplier, even on similar goods. Except in the broadest terms, there are no over-all standards or yardsticks which would enable the contractor to anticipate the outcome of renegotiation or to ascertain whether his treatment is relatively fair as compared with other members of his own particular industry.

There apparently is the further disadvantage of not knowing, perhaps for six to eight months after completion of the contract, what renegotiation demands may be. In the meantime the contractor has great difficulty in formulating his financial statements, in

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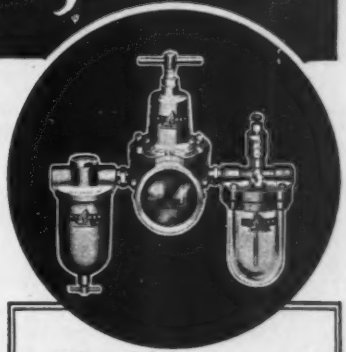

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It should be noted that the renegotiation principle has its enthusiastic supporters in the aircraft industry. Frederick B. Rentschler and Eugene E. Wilson, chairman and president, respectively, of United Aircraft Corp., had this to say about renegotiation:

"Final settlement of operating results at periodic intervals is of the utmost importance to the contractor. It permits settlement for deliveries under war contracts during the war period." In other words, these executives feel that renegotiation now will effectively dispose of the ghosts of World War II.

Here are some pointers which may prove helpful to the contractor.

Do not argue the law or its constitutionality with the price adjustment boards. To hand down opinions and decisions of this nature is the role of Congress and the courts; not of the government negotiators.

Remember that the work of the accountant is auxiliary. Briefs should cover not only accounting facts but also business facts, such as inventive contributions, efficiency, economy of operation, speedy deliveries, use of patents, and risks undertaken to fill government contracts. And don't be modest.

One more thing: It does not help to bring along a political lawyer residing in Washington, or a lawyer who has set himself up as a specialist in renegotiation, when you come before a board. Board officials cite some instances of "lawyer-accompaniment" where cases that could have been settled in 15 min. have taken four weeks or more —with nothing beneficial accomplished by the political lawyer or the specialist.

## Aviation's Postwar Portents

(*Continued from page* 120)

hostilities. Further, substantial contingency reserves for postwar use are being created, not only from earned surplus but also by virtue of the postwar refund of excess profits taxes to be ultimately funded by bonds receivable from the United States government.

One of the most substantial over-all postwar "nest-eggs" was created by United Aircraft Corp., this reserve aggregating $23,897,271 as of the last year-end. Similar reserves established by other aircraft companies are indicated in the accompanying table.

Of considerable importance to the retention of current earnings, and hence to the contribution that may be made to the future transition faced by the industry, is the process of contract renegotiations. The Price Adjustment Boards of the War, Navy and Treasury Departments and the Maritime Commission have agreed on the following principles in determining excessive profits:

1. That the stimulation of quantity production is of primary importance.
2. That reasonable profits in every case will be determined with reference to the particular performance factors present without limitation or restriction by any fixed formula.
3. That the profits of the contractor ordinarily will be determined on his war business as a whole for a fiscal period, rather than on specific contracts separately.
4. That as volume increases, the margin of profit should decrease, particularly where the amount of business done is abnormally large in relation to the contractor's own capital and plant, and where such production is made possible only by capital and plant furnished by the government.
5. That consideration should be given to the corresponding profits in pre-war base years of the particular contractor and for the industry. It should not be assumed, however, that a contractor is entitled to as great a margin of profit as that obtained under competitive conditions in normal times.
6. That the reasonableness of profits shall be determined before provision for federal income and excess profits taxes.
7. That a contractor cannot be expected to earn excessive profits on war contracts merely because he lacks adequate working capital in relation to a greatly increased volume of business.

The government boards further asserted that the existence of excessive war profits did not necessarily indicate that a contractor had taken undue advantage of the government or that the contracting officers had failed to exercise good judgment. Since industry had been called upon to produce war equipment for which accurate cost data did not always exist, cost and profits often had to be estimated. As a result, contractors were sometimes left with profits which they neither anticipated nor desired.

The moves toward standardization and improvement in the processes of contract renegotiation are likely to make

for happier business relations between the government and the aircraft industry along with other industrial groups as well. Some observers believe that a number of recommendations of the Truman committee may also be incorporated in renegotiation procedures and should have a good effect on industry.

Among other things, the Truman committee proposed that profit incentives be held out to suppliers showing efficient operation and that more liberal profit margins be allowed contractors who create reasonable reserves for postwar reconversion. The committee condemned cost-plus contracts and suggested the so-called future-pricing policy be adopted more generally. Using this method, a high degree of profit incentive can be provided by giving contractors who perform efficiently and at low cost in the first four months of a contract period, a larger estimated profit margin for the second period.

As a matter of interest, Douglas Aircraft Co. is a staunch believer in cost-plus contracts as a medium in maintaining war profits at a low level. On the other hand, United Aircraft believes that a fixed-price arrangement, subject to renegotiation is the satisfactory approach. The Glenn L. Martin Co., also appears to favor the latter view.

In any event, contract renegotiations have been a vital factor in lowering the cost of the war production program and will continue to exert a potent effect in the postwar transition. Yes, contract renegotiation will be with us for some time to come.

## Alcan Highway . . . Pioneered from Air

(*Continued from page* 116)

to fly cargo to our Alaskan bases. Naturally, it was anxious to have the highway follow the same route so that its planes could be serviced along the highway. The airfields were completely isolated from all land communication, and all refueling gasoline had to be flown in by planes which might otherwise have been carrying a useful load.

As the Ferry Command explained, airplanes could help enormously in the building of the highway by flying equipment to points along the way so that construction could start simultaneously in many different areas. Later, trucks driving along the highway could carry gasoline and other supplies to the airfields. The Ferry Command also pointed out that an inland highway would be less vulnerable to attack from the air. Moreover, it would offer a shorter route for military equipment coming from our defense factories in the East, the Midwest, and the South.

Therefore, the Canadian-American Joint Defense Board turned aside the "A" route along the Pacific Coast, chosen by the American Commission and urged for 14 yr. by Donald McDonald, also the "B" route a little to the east, recommended by the Canadian Commission for economic reasons—and decided on the "C" route, which Yukon Southern had developed and which the Ferry Command was using.

Today's airfields are by no means the primitive affairs of bush flying days. All of them have been taken over by the Canadian Government, enlarged to accommodate big Army bombers, and supplied with the most modern equipment. Scattered through the wilds of northwest Canada are numbers of airports with features as up-to-date as La Guardia!

Throughout the construction of the highway, United States Army planes constantly landed at these airports from American bases, bearing vital supplies and equipment. In one ten-day period, for example, the Ferry Command flew about 100,000 lb. of machine parts into northern Canada so that construction could go on.

However, the flying of cargo was only one of the many functions of the airplane during the construction of the highway. The first job to be done after the highway was voted was to determine the exact route, and this job was carried out largely by planes. Previous proposals and surveys had all been for routes along or near the coast. To be sure, a trail had already been blazed for 50 mi. northwest of Dawson Creek to Fort St. John, and the route beyond Whitehorse coincides with earlier recommendations of the American Highway Commission.

But from Fort St. John to Whitehorse the highway had never been surveyed. Planes flying at altitudes from 7,000 to 20,000 ft. mapped this whole country by aerial photography. Using the newest methods of stereography, they "shot" oblique strip photographs from perspective angles. Paired up and viewed through the stereoscope, these photos gave an accurate picture of the contours of the land.

Particularly helpful with this work were the veteran pilots of Canadian Pacific Airlines, which early in 1942 brought under one management ten northern bush lines, such as Yukon Southern and Canadian Airways, to operate a network of north-south airlines throughout Canada. Having flown over the territory many times, these men

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were well acquainted with the land and used to flying when the thermometer read 50 deg. below. Necessity had taught them how to start their engines and keep them running in sub-zero temperatures and how to repair their planes themselves. Sometimes they had been out in the no-man's-land of the north for exceedingly long periods without getting back to their bases to have their planes overhauled. To them went the job of flying survey parties out in bush planes to chart the road route.

Before the outbreak of war, Canada's airlines led the world as commercial air cargo carriers and they still rank high. In 1942 much of their air express was carried for the United States Army. During the construction of the highway, Canadian Pacific planes rushed essential parts to the scene when breakdowns occurred. They served as ambulances in case of accidents. They flew key men to strategic places for conferences. They carried important messages and documents. At one time they were carrying some 50,000 lb. of air mail a month to United States Army camps along the highway. All in all, over 90 percent of all CPA operations in the Northwest was devoted to defense projects.

One of these projects is serving the immense pipeline which is being built down the Mackenzie River basin. The Joint Defense Board realized that the highway would be worthless without gasoline to supply the trucks. Therefore, it started negotiations for speeding oil production along the Mackenzie River and for building a pipeline to the highway at the same time that it was making arrangements for the highway.

On this project alone, at least 10 and sometimes 15 or 20 CPA airplanes were working during the summer. They photographed entire sections of the country from the air. They flew countless tons of express, freight, and food supplies into otherwise inaccessible places. They kept in daily touch with the barges along the rivers, finding out what they needed and supplying it.

Even now the prime work of the airplane is not finished. Though the highway was opened to big Army trucks for use this winter, there is still much to be done both in constructing and supplying the road. During the spring thaws it is expected that most of the temporary wooden bridges will be washed away, and plans have already been made to replace them with more permanent ones of concrete or steel and to relocate them if necessary. The road itself will have to be widened and surfaced. Other highways are being built to connect with the Alcan, and new oil wells are being developed to feed the highways.

In all these projects, airplanes will continue to play an important part by providing transportation where no other is available and by providing quick transportation where the need is urgent. Having pioneered the actual route of the highway, they will continue to service it and, in turn, will be serviced by the highway.

## Wanted—A National Aviation Policy

(*Continued from page* 113)

1945 would of necessity be flying in 1939 equipment. It is inconceivable that immediately following the war any other industry is going before the public with antiquated products.

One of the most encouraging signs for the aviation development in the postwar world is the indication that our own State Department is now developing an air policy program which is to be discussed at the United Nations meetings on postwar problems—meetings which may be presumed to be going on at this very moment.

However, there is one aspect of such planning by the State Department and the United States Committee on International Aviation Policy which is not healthy. I refer specifically to the composition of the committee. One cannot quarrel with the brilliance of thought contained in the membership, which is certainly distinguished. But I do protest against the failure to include on this committee representatives of the manufacturing and transport groups of aviation. In other words, there is a tendency for government, through a committee composed of representatives of the various governmental departments, to create and possibly establish a policy and at the same time commit the aviation industry to it without first seeking advice and counsel. If the aviation industry is to fly passengers and cargo to and from foreign countries under such agreements, it is only just that the industry's guidance be sought now when these agreements are being developed for presentation.

There is another phase of the value at this time of postwar discussion by the aircraft industry, a phase believed to be unique insofar as the other business is concerned. Almost everyone is familiar with the expansion and growth which the aircraft industry has undergone. Most companies have multiple

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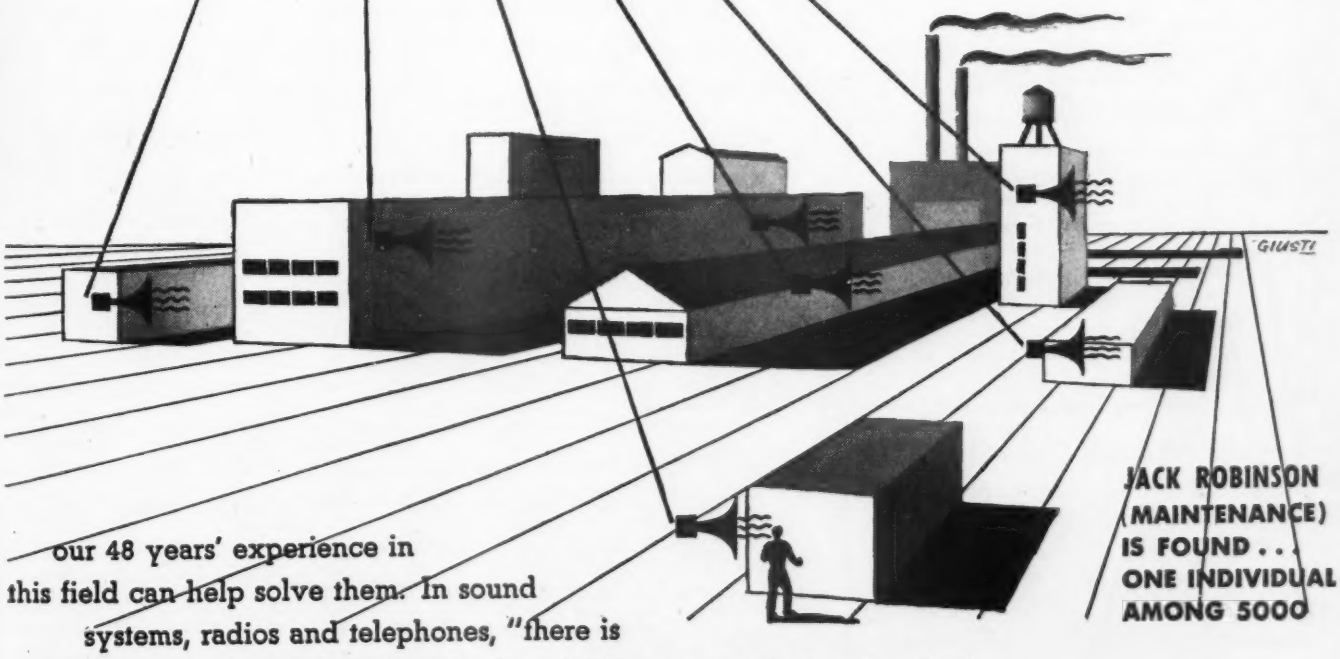


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plants located in all sections of the United States; they have taken in men and women of all ages and from all occupations, trained and developed them into competent aircraft workers by hundreds of thousands. The majority of them are thoroughly aware of what the pre-war aircraft manufacturing situation was. Naturally, they are justified in whatever doubts they may have as to their chances of employment in their recently learned trades after this war.

Thus it is my belief that if aviation management can indicate to the men and women in the industry that it—management—is giving serious and sincere thought to what the industry will be producing in the peace, it will prove to be, next to attempting a quick and positive victory, the greatest of all morale builders for our workers.

If the aviation industry is to continue to prosper, setting its sights now is not at all premature. As an industry it has a responsibility to all the people. It must strive to see that its existing industrial mechanisms are continued in order to maintain productivity far above the prewar level and to provide employment for all who want to work. The industry will do this.

Thus far the picture presented has been somewhat dour. There is, however, another brighter one. I am fully convinced that aviation is, at long last, to enjoy an extended prosperity with relation to transportation of passengers and cargo, and as a means of opening hitherto potential but inaccessible markets. The work has been made just so much easier by the herculean job done in this war by the Air Transport Command, which should be given highest praise for its fine work. Naturally, military restrictions have prevented more than meager details of the performance the ATC has been turning in day and night, which to the command itself is simply routine.

When that story is told, I predict that it will be one of the most thrilling to come out of the war. The pioneering of shrinking the globe has been done by the Air Transport Command, and the airlines will pick up where the command leaves off. Continents and markets for American products are no longer hedged in by barriers of oceans and mountains. They have now been reduced to distances measured by hours instead of miles. The importance of a city because it was a seaport has been eliminated. This will be because the aircraft manufacturers who are now building planes to secure freedom of the air will provide the nation with planes to make use of that freedom.

The transport and cargo planes which will be available almost immediately after this war are beyond the embryonic state. Their speeds and capacities are

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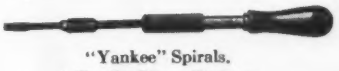

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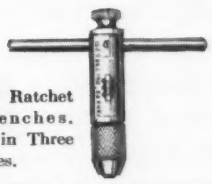

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assurance that America's chances in competition with the merchants of any other nation for a foreign market are definitely equal. Anyone skeptical of the aircraft to come should bear in mind that while it is a brutal manner of approach, this war is serving as a test laboratory for peacetime flying. Most of the larger transport and cargo planes developed by Curtiss, Lockheed, Consolidated, Boeing, and other aircraft manufacturers, to fly war materials will be further enlarged and will be taking you or your goods to far-off points normally inaccessible to other forms of transport.

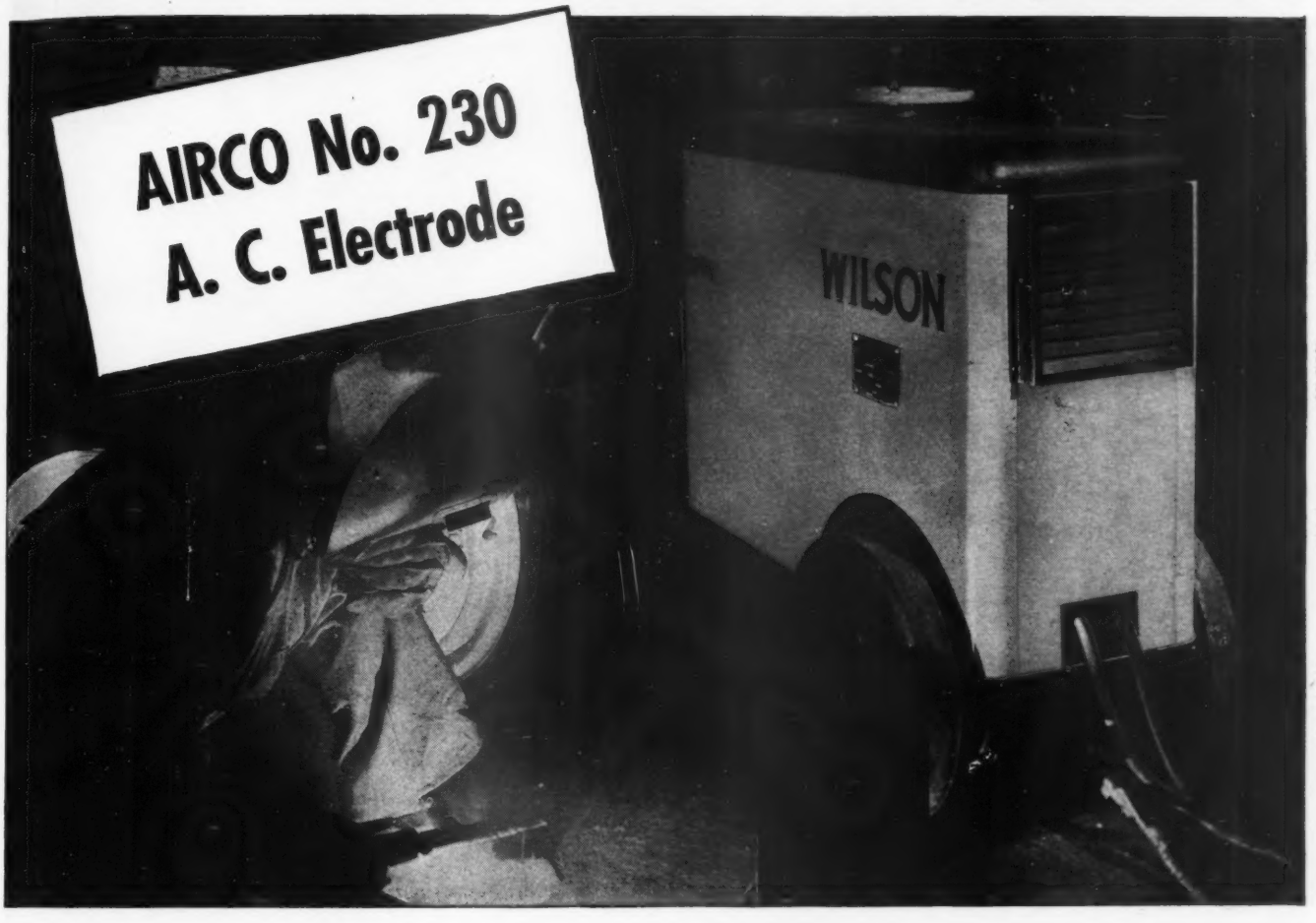
Aircraft manufacturers are no longer talking about 44 passenger airplanes. They are building, or preparing to build, planes carrying 100 or more passengers; one reports on preparation of a mock-up of a 400 passenger craft. With such planes in the offing, it isn't unlikely that air rates for passengers will be substantially reduced; and with cargo rates, which have hitherto been almost heavy, similarly reduced, it is easy to see why every industry in the country, through the sale of its products, will have a hand in changing the living habits of this country and the world.

When we come to forecast a positive program we find the prediction field has already been over-run with 1,000-mph. planes in numbers to darken the sun, landing in our own backyards, made of colored plasties, doing 59 or 60 mi. per gal. of gas, and within the price of every citizen. It would be hopeless to attempt competition with such statements, and because the superlatives have already been used up and made the headlines for which they were intended, I relegate them to the fringes of probability.

One should, however, answer one question which undoubtedly will be asked: What do the auto companies in aviation offer? I do not believe that the automobile manufacturers will remain in the airplane industry after this war. First, all the automobile companies will have a tremendous market for their regular products due to the wartime manufacturing restrictions, which will have been in effect for nearly three years and, second, because the conversion of the automobile industry to airplane manufacture, noteworthy as it has been, has shown that the glib quotation of a motor magnate a few years ago about turning out 1,000 planes a day has not and probably never will be true.

In stating that I do not believe that the automobile industry will be in the airplane business, please note that I am talking about *airplanes*. Definitely, I feel that the automobile manufacturers will be in the engine, accessory, perhaps propeller and similar allied fields,

# for TOP-FLIGHT WELDING in all positions




Faster welding and better quality welds in the overhead, vertical, and flat positions—that's what the Airco No. 230 AC electrode makes possible. Used with alternating current, the Airco No. 230 provides a stronger, forceful arc that eliminates most of the difficulties usually met in vertical and overhead welding.

Airco No. 230's special extruded coating, together with its spraying action and greater arc force, permits rapid solidification of the weld deposit and faster deposition speeds. At the same time, the quality and contour of weld deposits is always excellent. Recommended for the welding of mild steel, Airco No. 230 is also ideal for welding low-alloy, high tensile steels where sections thinner than 1/4" are used, and where such materials are chosen principally for their high tensile strength.

Airco No. 230 AC electrode is made in 1/8" and 5/32" dia., 14" length. It meets the requirements of Classification E 6011 of AWS and ASTM Specification A233-42T; and A.S.M.E. Boiler Code, Paragraph U-68. In addition, Airco No. 230 AC electrode bears the approval of the American Bureau of Shipping, under Group Classification H1G and B1G. For further details on the Airco No. 230, write your nearest Air Reduction office.

## *Stretch your D. C. electrode supply with Airco No. 63*

Use Airco No. 63 Washed Coat electrode for tacking, light fabrication, and similar welding work not subject to code regulations. Airco No. 63, available on low priorities, has a light surface coating which improves arc stability and operating characteristics over those of bare electrodes. Made in five diameters—3/32", 1/8", 5/32", 3/16", and 1/4". Write your nearest Airco office for details.

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**General Offices: HOUSTON, TEXAS**

AIRCO

WILSON

**IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!***

# OUT OF THESE FLOCS MAY COME THE FUTURE OF THE WORLD

These white crumbs or "flocs" look very unimportant in themselves . . . but on them may depend the future of the world. They are one of the first stages in the production of synthetic rubber, the most vital material being produced in America today.

Naturally, you are interested in synthetic rubber. But synthetic rubber is only incidental. What is really important is what happens to synthetic rubber after it is actually produced. It is chemistry that makes rubber fit to use, suits it to the task at hand.

United States Rubber Company is the largest manufacturer of rubber chemicals in the world. We have worked with rubber, improved it and broadened its uses for 100 years. Today, all this tremendous fund of knowledge of the chemistry of rubber is being drawn upon to improve synthetic rubber, perfect it for the jobs it must do for the Armed Forces and war industry.

The chemistry of rubber is what determines the final compounding and processing of the flocs of synthetic rubber you see here. They may eventually go into bullet-sealing hose, air ducts, or any one of a score of other parts used in the plane that will blast the last Nip carrier off the sea. They may be made into a tire that will rumble down bomb-battered Unter den Linden. They may go into some essential equipment like a conveyor belt that will keep America's war production line moving at top speed. They might very easily determine the entire course of the war, and thereby the future of the world.

Synthetic rubber, its production, compounding and application to war and industrial uses, is too big a story to present adequately here. There are five basic commercial types of synthetic rubber. Each of them has distinct properties and characteristics. Not a single one is ideal for all purposes.

Deciding which synthetic rubber to select and use for a particular task is an equally big story, a decision that requires expert knowledge and broad range experience.

We have told the story of the five basic commercial types of synthetic rubber, our more than twenty years of experience in working with them, and our twelve years of using synthetic rubber commercially in an interesting, informative booklet. Send for your copy.

## UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE, ROCKEFELLER CENTER, NEW YORK

In Canada: Dominion Rubber Co., Ltd.

but not in the main field of plane building itself.

In the private flying field I believe we will see large advances in numbers of airplanes owned, but I feel we should be careful to define our terms even there. Just before the war broke out we had in this country approximately 30 million registered automobiles. We all know that it takes a negligible amount of mechanical or scientific knowledge to operate a car. Most people get by merely by being able to distinguish between red and green and recognizing filling stations.

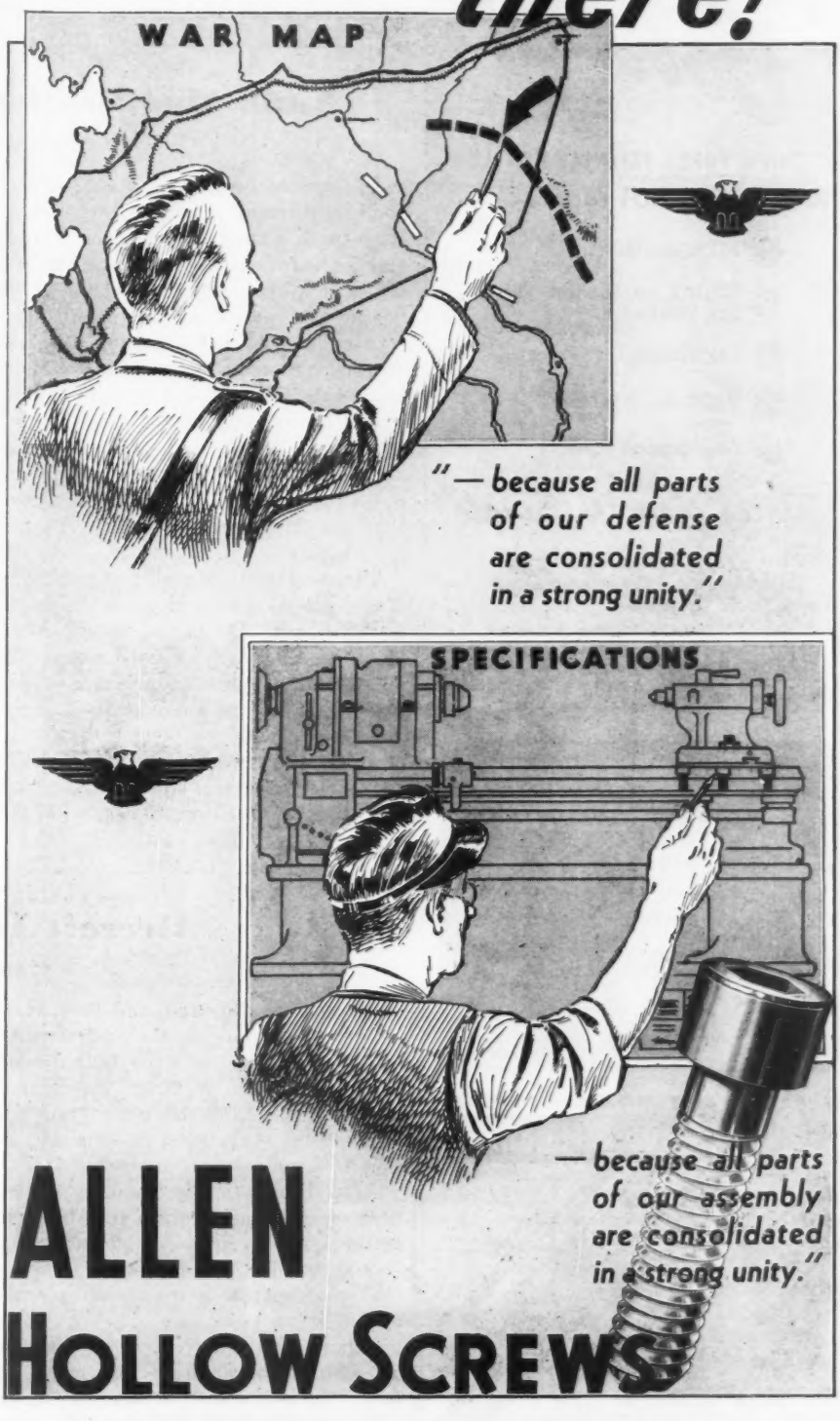
At the same time that we had 30 million cars we had approximately 300,000 licensed motor boats. It is unnecessary to elaborate on this obvious conclusion: More scientific and mechanical knowledge is required to operate a motor boat than is needed for an automobile. While we had all those cars and motor boats we had only 30,000 aircraft of *all* types in this country. That figure is all-inclusive—the private planes, those owned by the Army and Navy, and the equipment flown by the airlines. Because of many contributing factors I do not believe the ratio will be materially changed following the war. We will in all probability have more automobiles and motor boats and airplanes than ever before, but the increase in the number of aircraft will bear some semblance of the same proportion between automobiles, boats, and airplanes as that which existed before the war. The ratio for airplanes, due to the increasing airfields, may be materially improved, but it will still be far behind the numbers of automobiles, and much more comparable to the numbers of boats.

### No More "Distant Places"

I know now of certain postwar aviation plans and am confident that the possibilities for the transport and cargo plane are practically unlimited, except for possible political stifling. There can never again be distant places in the natural course of existence. It is easy to comprehend that when London, New York, and Los Angeles are near each other in terms of time, they will be much nearer in terms of thought, habits, trade, and understanding. The day is now not far off when we will be able to race the sun from New York to Los Angeles and not do a bad job of it—leaving New York at noon and being in Los Angeles at 4:00 p. m., Los Angeles time. Going in the other direction, we will be leaving New York at 5:00 p.m. and getting to London for breakfast.

And leaving London at eight in the evening we will arrive at New York in the morning. Of course, it will take planes capable of cruising at least 400 mph., but as a result of what we have


"WE *shall* HOLD *there!*"


WAR MAP
"— because all parts of our defense are consolidated in a strong unity."
SPECIFICATIONS
— because all parts of our assembly are consolidated in a strong unity."

ALLEN
HOLLOW SCREWS

HOLLOW SET, SOCKET HEAD CAP, FLAT HEAD CAP
and "TRU-GROUND" SHOULDER SCREWS

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HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.

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"NEW YORK'S FRIENDLY HOTEL"
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Permanently Accurate
Torque Wrenches

A Complete Line

of permanently accurate measuring and gauging wrenches that are standard in leading war plants for gauging and controlling torque in production and for testing and measuring in inspection. Indestructible flat beam construction. Double scale visible from all working angles. Capacities from 0 to 7200 inch pounds.

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Friction
Adjustments
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Fragile
Mechanisms

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

learned in this war those planes will be available.

When it comes to the composition of our own towns, large or small, it is easy to see what will happen when the normal daily commuting distance to work may be stretched to 200 mi. Residential areas of the cities will then fan out in concentric circles. Naturally, this must bring about coincidental view-points and attitudes of city and country, of community and community.

Through the airways of the future the understanding of America will be so broadened that it cannot help but temper the world. All this is a practical possibility—let us not allow bureaucrats to stop its consummation.

## Yank Modification Center in England

(*Continued from page* 255)

ever, have some of the "comforts of home," operating in a large, well-lighted room with sufficient space for records and an information section where statistics on all projects are filed.

The vast production branch handles repairs and normal overhauls, as well as making modifications to Wright, Pratt and Whitney, and Allison engines, together with propellers and instruments. It is equipped with large machine and assembly shops, and it was noted that the production charts proved that the Army servicing program was on schedule.

The production branch has a self-contained planning section operating in accordance with the latest factory ideas, and here colored wall charts give plentiful visual indication of progress. Each make of motor and components is segregated, and each component carries its own large stores accommodation. The raw materials stores are separate from this section, occupying nearly 17,000 sq.ft. of floor space.

Glenn D. Waring, factory representative, told of the company's planning for staff welfare—a tough job. The base is located approximately 20 mi. from the nearest town, and with the consequent transportation difficulties, elaborate arrangements have been necessary for staff relaxation and amusement. The base has its own theater, with a seating capacity of 500, where the latest films are shown and, twice a month, stage shows are presented. Outdoor sport facilities include, of course, baseball diamonds with their own "National" and "American" leagues now getting into spring training. Facilities have also been provided whereby staff members may study almost any subject, ranging from aeronautics to violin playing.

At dinner the last day—a typically good meal of fine American food—the Stars and Stripes over the table served as a reminder that the whole project typified the United States' part in the war—swift to meet change and always growing in power.

## Aircraft Tool Planning

(*Continued from page* 181)

plant that can be used, and then which of these machines is the fastest operated that will maintain the desired tolerances of the part. Next, the special tooling that will fit the chosen cutting and forming machines must be efficient and easy to handle.

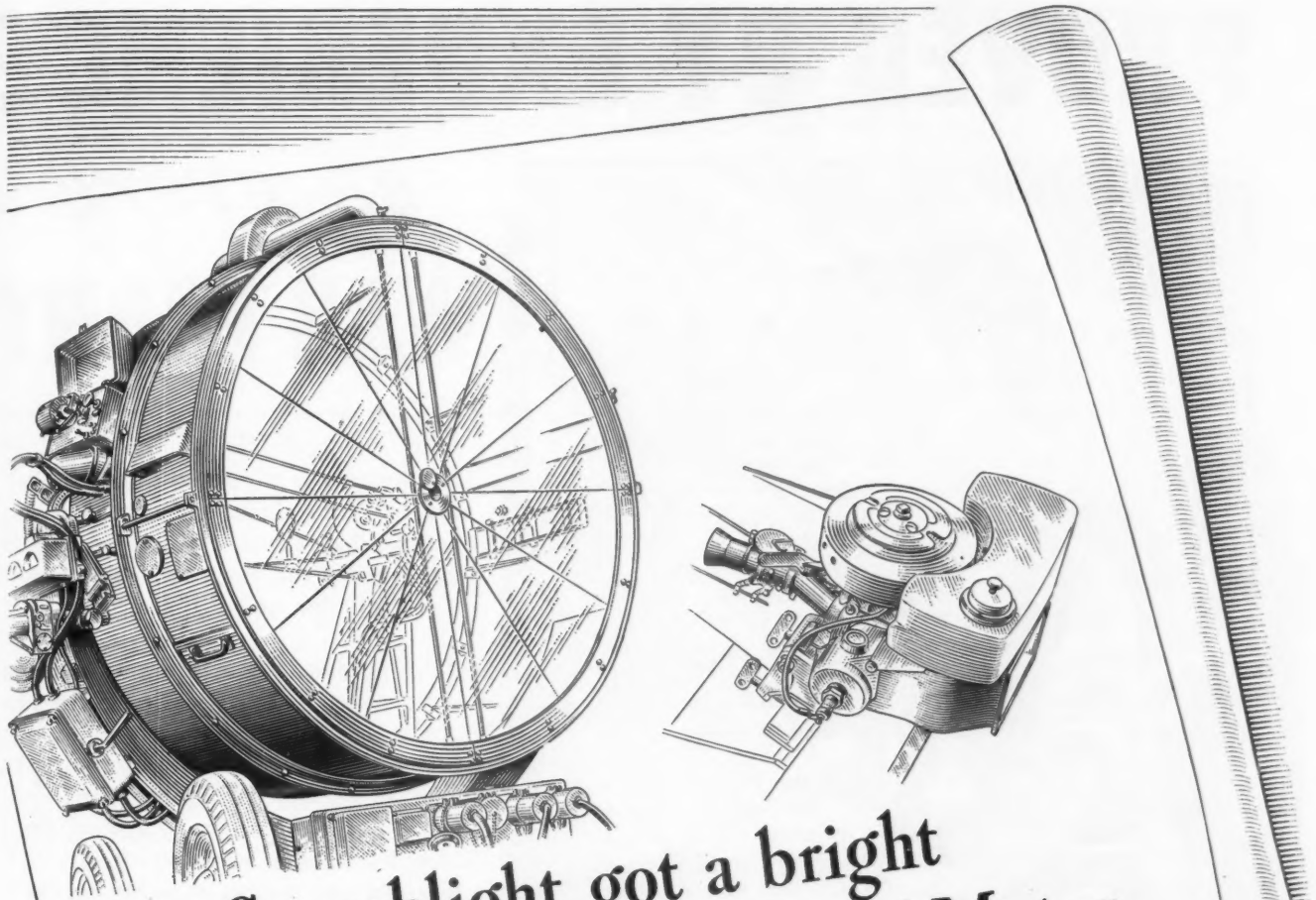
After fabrication is definitely settled, then serious consideration must be given to the assembly problem. Actually this should be first, because depending on the coordinated setup, the planner should know how close his detail tolerances must be held. Any one of the four systems of coordination presents problems that reflect on the assembly methods used. However, the assembly tooling chosen must hold required tolerances and must be efficient in its own operation. Poorly fabricated parts require more complex assembly tooling; thus, clear thinking on the part of the planner, and a workable and practical system of coordination, will eliminate fabrication and assembly difficulties.

### 16. Tooling Time

Good tooling requires time, careful workmanship, and rigid checking of its construction. Time is just as important an item in tooling as it is in the production of parts and requires even more careful planning and forethought.

Unfortunately, tools are always a rush order; they are always wanted "yesterday", as the common expression goes. *To rush the "starting point" or "beginning" of parts, such as tools are, is a very poor and inadequate policy.* The job of getting a ship into production requires first that the tools for this job be made.

The tool planner must realize that certain tools will take longer than others because of their nature and structure. Since war demands speed, full utilization of time, and production of ships, the tooling program must fit in and conform to this schedule. In caring for this, the tool planner must realize that his job in some cases will result in



# The Searchlight got a bright idea from the Outboard Motor

OFFHAND, you wouldn't think there was anything in an outboard motor that could make the going easier for an anti-aircraft searchlight. In designing "outboards," the chief requirements are small space and high load capacity. So builders of outboard motors chose the Torrington Needle Bearing—it's unusually compact for an anti-friction bearing, and noted for high load capacity.

In the anti-aircraft searchlight, size of parts is a secondary consideration, so long as the equipment is transportable. Yet searchlight designers, ever striving for quicker response in locating enemy aircraft, welcomed the Needle Bearing as eagerly as outboard motor manufacturers. And not merely for its high load capacity, which helps prevent overloading and breakdowns, or low coefficient of friction, permitting crews to swing a searchlight's beam into immediate action at the first warning signal.

There's the Needle Bearing's reliable performance, for example—an invaluable feature when enemy planes are overhead—its effective system of lubrication, which enables the bearing to run for long periods without *any* attention at all—and its ready availability, helping to provide our Armed Forces with enough and on time.

### NEEDLE BEARINGS FOR ALL PURPOSES

**LOOSE ROLLERS** are produced in a range of sizes for assembly into low-cost, high-capacity anti-friction bearing units. They are particularly adaptable to applications where volume permits installation of the necessary equipment.

**NEEDLE BEARINGS** are complete, self-contained units consisting of a full complement of rollers and a thin, hardened outer race. They offer the advantages of small size, low cost, high capacity—and are easily, quickly installed.

**QUILL BEARINGS** consist of a full complement of rollers and a relatively heavy hardened outer race. They are furnished with or without inner races. Quill Bearings are adaptable to heavier load requirements than Needle Bearings.

*THERE MAY BE AN IDEA HERE FOR YOU, TOO,* in planning your product's post-war designs. Savings in weight, compact design, infrequent lubrication, dependable operation—these are features your regular customers most likely will insist upon after the war, and the Needle Bearing has every one of them, as well as low cost and ease of installation. Now is the time to "iron out," with the help of Torrington engineers, the details in adapting the Needle Bearing to your particular applications. For preliminary information on sizes, ratings, and typical applications, send for Catalog No. 114.

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LET'S GO WAR-KEEP 'EM FLYING

## TORRINGTON NEEDLE BEARINGS

# PROVED BY EXPERIENCE

## *on every* WAR FRONT

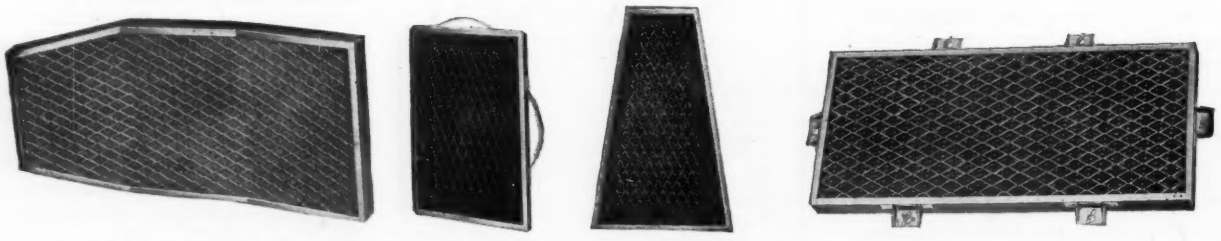
● *AAF filters for airplane engines are but part of a complete line of air cleaning and dust control equipment which this company has been making for more than 20 years.*

Reports from front line air fields continue to praise the effectiveness of American Air Filters in guarding our planes from dust. The extra flying hours which dust protection makes available often turn the tide of battle when the going is roughest.

AAF engine intake filters have been developed in cooperation with aircraft engineers to meet varying airplane construction requirements as well as Army Air Corps specifications. Experience has proved their effectiveness in keeping motors running longer, saving valuable replacement parts, and reducing oil and gas consumption.

Airplane motors *not protected from dust by air filters,* require overhauling and rebuilding after only 20 to 30 hours of flying time. When protected by AAF filters which remove 90% to 99% of the dust from the intake air engines perform efficiently for 300 to 400 hours!

**23 TYPES OF AAF AIRPLANE ENGINE FILTERS ARE NOW IN USE ON UNITED NATIONS WAR PLANES**



*AAF engineers with wide experience in the aviation field, are at your service to work with you on your engine filter problems. . . . Write us for complete information and performance data.*

AMERICAN AAF AIR FILTERS

**AMERICAN AIR FILTER COMPANY, INC., 346 CENTRAL AVE, LOUISVILLE, KY.**

IN CANADA, DARLING BROTHERS, LIMITED, MONTREAL, P. Q.

*double planning*. First, if it is necessary because of the complexity of the required tools, a set of simple tools will be ordered that will allow adequate cutting and forming. This will launch production with a minimum of tooling time. Second, after production is underway, the more proper coordinated and accurate tooling can be ordered. Thus production is not held up for the more precise tooling.

Sometimes this is handled, at the start of a new model, by means of *experimental* and *production* tooling programs. In that case the experimental tooling can be used to carry over into the production schedule until the production tools are released.

The tool planner must use a keen sense of judgment, realizing that tools require time to build, and at times the building of these accurate and proper tools means to release simple tooling first, thus allowing sufficient time for constructing the proper tools. The planner, therefore, not only visualizes and orders tooling, but he also must fit tooling into the production program in the best possible manner. Production today is the vital problem and merits foremost consideration; tooling time thus becomes secondary but still very important.

### 17. Shop Loading

Whenever a production program is set up, the loading of the tool and production shops (fabrication and assembly) become a very important problem of the tool planner. In considering first the tool shop loading problem, the aircraft tool planner has usually four tooling shops with which to deal, namely: The template department, the woodshop, the machine shop, the combined foundry and plaster pattern shop. Should any one of these departments become submerged with tool orders, the planner can follow one of *two plans* left open to him. Either he can have his tool orders sent to an outside concern to build them completely, or he can readjust his tooling program to use the type of tools made by another tooling department. An example of changed tooling will clarify:

*Example: A deep hammer die was ordered, and the orders were sent to the foundry and plaster pattern shop. Because of an overload in this shop, the planner changed his order to a hydro press die, thus shifting orders to the wood shop.*

Next, in considering production shop loading problems, the tool planner again might have to rearrange his tooling program to suit the urgent problem of shop loading. Should any one department become overloaded, shop routing must by-pass this particular department or departments. Usually when


# FACTS . . .

(Plus Some CAUTIONS*)

CONCERNING WARTIME

# RELIGHTING

Under present conditions, plant relighting requires careful study and competent planning. The War Production Board has established a procedure that requires proof of the individual necessity for relighting.

**DETERMINE YOUR NEED FOR RELIGHTING . . .**

A new lighting system is indicated by any of these five conditions: (1) Building is obsolete. (2) It is not equipped for 24-hour work. (3) It is inadequately converted for war work. (4) Excessive accidents to men and machines. (5) Present lighting is obviously deteriorated.

***GOVERNMENT APPROVAL is most likely IF . . .**

IF the request is for incandescent lighting (fluorescent lighting is severely restricted for many uses).

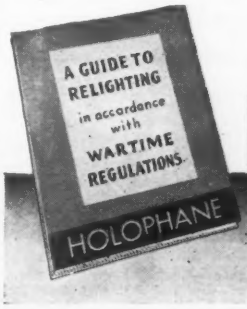
IF specifications are based on least critical materials.

IF the improved lighting will accomplish these ends: reduce spoilage of essential materials; break bottlenecks; prevent accidents; do a better job with a saving in power and maintenance.

**NOW CHECK THESE HOLOPHANE ADVANTAGES...**

- **LESS Critical Materials Used**
  The basic element of Holophane equipment has always been prismatic glass (non-critical). Installations require less metal, fewer fixtures, lower wattage, less wiring.
- **Manhours and Manpower Conserved**
  Holophane equipment provides correct seeing conditions which reduce accidents to workers and damage to machinery.
- **Electrical Power and Maintenance Cost Reduced**
  Holophane *Planned* Control provides maximum light with minimum current consumption—prismatic glass units (resistant to deterioration) are easily serviced.

**Consult Holophane Engineering Service—**
*for advice, without obligation, as to your lighting needs and correct methods of procedure. Write for new Holophane Bulletin: "A Guide to Relighting in accordance with Wartime Regulations".*

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On a dangerous mission far from his base . . . isolated from his fellows by clouds or enemy attack . . . the military flyer has this inspiring reassurance: his words, spoken into the dependable, sensitive microphone, will be heard instantly by scores of fighting comrades.

Kellogg microphones, made to the high performance standards of the Armed Forces, are serving our fighters not only in planes. In rumbling tanks, speeding command cars, in combat vehicles of every type, at airports and ground stations, their sensitivity, ruggedness and accurate transmission qualities are in the thick of battle.

Into their manufacture goes the same specialized engineering skills—the same precision methods of manufacture—that have made Kellogg an honored name in the whole field of communications for almost half a century!

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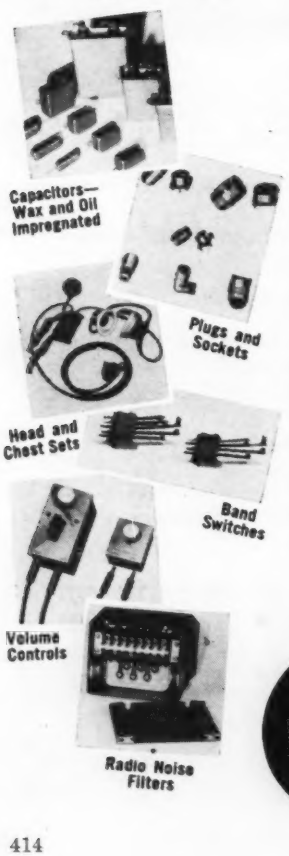


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WHERE ENGINEERING AND RESEARCH BUILD
*Finer Communication Equipment* FOR WAR AND PEACE


shop routing is changed it involves a slight change in tooling, although this is not always true. An example will clarify:

*Example: A sheet metal part was made on a hand form block in the hand forming department. Heavy shop loading in that department made it necessary to re-route the parts for forming on the hydro-press. This involved a change in the shop routing cards and the ordering of a hydro block.*

Shop loading is very real and becomes an additional problem for the tool planner. *The intelligent planner is always aware of two or three comparable methods* of forming the same part just in case of such emergencies. Nowadays, the planner is relieved of the problem of shop loading by departments set up for that purpose. Nevertheless, the tool planner should be fully aware of these conditions and cooperate to eliminate such.

### 18. Shop Routing

It is an ever-present problem of the tool planner to carefully route his parts through the shop, so that operations are in the right sequence and succession, that orders are concise and direct, routing from department to department is well organized, and that there is no repetition of operations or departments. Each department should do its work completely and pass the part on to the next department for further work.

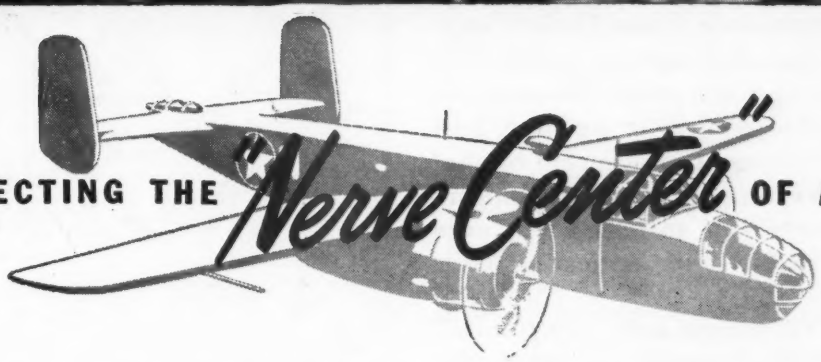
Crisscrossing of departments delays production and causes considerable confusion. It ties up physical operations of transferring parts and creates excessive handling. Good constructive tool planning in shop routing will alleviate this condition. The tool planner should be well acquainted with the shop layout of the machinery, and thus route his parts accordingly. Complete knowledge of plant layout, and floor plans of the tool and production departments, are essential requisites of good tool planning.

### 19. Human Error

At no time in man's history has a problem of manufacturing been considered, but that the problem of human error has not entered into the discussion. Tools must be ordered and built to accommodate the worker as well as the part to be made. No tool is fool proof because it requires human operation. Tools should be made so that the least possible of human errors can enter into their use.

The tools should be easy to handle, especially now with the multitude of women industry workers. The tools should be simple to load and unload with parts or assemblies. Location of parts must be exact and easy to accomplish. All possible chances of mislocating a part

Photo by Office of War Information



## PROTECTING THE "Nerve Center" OF A B-25 BOMBER

The young lady is attaching terminals to the panel of an electrical junction box, shortly to become the "nerve center" for a big B-25 bomber. To protect against static interference, incoming and outgoing wiring is encased in Flexible Low-Tension Shielded Conduit made by American Metal Hose.

Wherever planes fly, this battle-tested conduit is playing its part in supporting brilliant performance... enabling radio signals and directions to come in clear and undistorted. It is one of the important "tremendous trifles" that are helping American wartime aviation set so many outstanding records.

American Metal Hose makes a complete line of fittings and accessories for American Flexible Low-Tension Shielded Conduit. Both fittings and conduit conform to A-N, A-C and NAF specifications. We are also prepared to make complete assembly of conduit and fittings to meet individual specifications, thus conserving valuable time on the production line for aviation plants. Inquiries will receive prompt attention.

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# Even the Most Minute Part Has Its Big Moments

The contact points in a fighter plane's "turn and bank" indicators are not much for size, but they must be brutes for action. Like all component parts in a plane's electrical apparatus, they must function perfectly or spell trouble for the pilot. Always, he must be sure of his maneuver.

Under war need's pressure, a new type "turn and bank" indicator—an instrument in which the pointer remains stationary to show the degree of deviation from normal flight—called for contacts capable of operating 75 times a second, but extremely sensitive. Tiny contacts they are, less than a tenth of an inch in diameter, but they make and break the circuit that controls the speed of the gyroscopic motor.

Early in the designing, Mallory contact experience was sought. Standard contact materials set up excess arcing, creating unwanted radio interference. Then Mallory metallurgists, working against time, developed a combination of metals—standard tungsten for one point, Elkonium-34 for the other—that licked the problem in jig time. Just one contribution to the development of accurate combat maneuvers, to be sure, but an excellent example of how concentrated cooperation is functioning to insure that even the most minute part does its bit at the critical moment.

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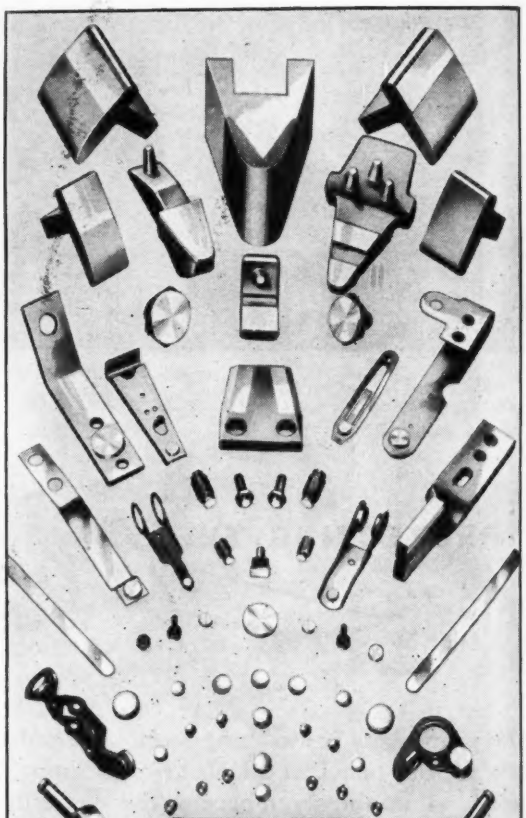

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must be mentally thought out and provided against in the tool. Simplicity of the tool allows the worker to be free of worries for fear of doing a wrong job. A simple tool is many times an inducement to speed up work, and it gives the operator confidence.

Today, more than ever before, must the tool planner realize his job and responsibility in providing adequate and proper tooling. The tool must eliminate fear, insure confidence, and be usable and practical. This is a real job for the tool planner.

#### 20. Shop Personnel

Highly trained and skilled shop personnel requires little tooling to build parts and assemblies, whereas inexperienced help needs considerable tooling and instructions for its use. At present the aircraft industries are greatly in need of skilled and unskilled help, and as such the shop personnel is a mixture. Therefore, in any organization, where there is a weak link present, it must be given all consideration. Thus, with personnel untrained, as is the case today, it is for this class of workers that tools must be made. The tool planner is key man in accomplishing this. Careful planning and due consideration for the workman can do much to aid and boost production even with unskilled labor.

The aircraft tool planner, to handle successfully his important responsibilities, must have a background of aircraft experience, a technical education, and the ability to make decisions. He must be a salesman in "putting over" his tools and methods of manufacture in the production shops, also in assisting the tooling shops in making the desired tooling. The tool planner's choice of tooling and methods of manufacture can either make or break his company. To chance new methods and tooling for fabricating or assembling is a tool planner's prerogative; it is the foundation of improvement and advancement, but it must be done cautiously.

Thus the aircraft tool planner ranks with the aircraft engineer as his work is the important "tie-in" between the engineering blueprints and the manufacturing production lines. His place is definite in the aircraft industry and one of extreme importance.

## Flight Testing Is a Sound Business

(*Continued from page* 119)

memorize and practice the three emergency high altitude flight procedures, until they become almost second nature to him.

The first emergency procedure is for bailing out of an airplane at any altitude, although most time is devoted to the high altitude phases of this practice. The men learn to take the following successive steps in this order: Unfasten safety belt; open all doors inside the airplane, unless a door is needed to isolate a fire; if a jump is necessary, turn on emergency oxygen system; remove flight oxygen mask, put emergency mask on; put goggles over eyes; exit from plane, making certain to clear the airplane; pull rip cord after the plane has been cleared and/or when warmer altitude is reached; try to land in the direction of drift; inflate life vests if over water, or if above clouds and water landing is uncertain; cross the feet and keep legs together, to make certain not to straddle trees or fences in landing; and if landing is made in water, unfasten parachute leg straps before striking water.

Emphasis is placed upon the fact that from high altitudes, a man might not reach ground safely if he were to jump and open a parachute immediately. The men are taught to stay inside the plane whenever practicable until the plane reaches a more moderate temperature, probably 15,000 ft. If the plane should be untenantable, the man should fall free until he reaches a warmer atmosphere before opening his chute.

The second emergency procedure deals with changing oxygen systems. This first entails opening the oxygen valve and tapping lightly. Put on stand-by mask if the regular supply of oxygen cannot be fixed immediately. Should stand-by system fail to function properly, turn on emergency bail-out oxygen supply and use bail-out mask. Help in any of these changes is to be given by another crew member, if required.

The third emergency procedure deals with collapse of a crew member, such as by failure of his oxygen system. First step is for another crew member to administer oxygen. The stand-by mask should be held tightly on the face of the stricken crew member, fastened into position, and checked to assure that the oxygen valve for this system is turned on. The aiding crew member should make certain that his own oxygen system is not cut off due to his movements. Should the stand-by system fail to function, the emergency bail-out bottle and mask are brought into use. Meantime, the pilot should be notified, so that he may take the plane to lower levels. Artificial respiration should be administered if the occasion requires.

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tains oxygen which will last a man for about 20 min. Its uses are many, as is readily apparent. Aside from the regular oxygen supply, the stand-by system, which is checked for operation before each flight, provides three different oxygen systems.

After committing the procedures to memory, the crew members practice them until they become proficient. Having successfully completed their training program and safety precaution lessons, they are ready for a final examination, the passing of which will qualify them for a place in a flight test crew. The last test is a simulated flight in the Boeing Stratotrainer.

### Differs From Stratochamber

The Stratotrainer, designed by the flight test department, is for the specific purpose of training crews in high altitude procedures. With accommodations for eight men at one time, it is considerably different from the dual compartmented Boeing Stratochamber, the first low pressure chamber put into operation by an aircraft manufacturer for training work.

A typical training crew is composed of seven new men and one experienced man. As the air within the Stratotrainer is evacuated, the conditions simulate those of ascending. A refrigeration unit reduces temperatures inside the trainer to correspond to those within a plane on a high altitude flight. On a typical test, the motors are stopped when the interior atmospheric pressure of the Stratotrainer equals that encountered at 35,000 ft. Here each man performs the three emergency procedures under conditions which he may encounter on subsequent high altitude flights.

At this altitude, there is approximately a 40-sec. margin of safety for changing oxygen systems. Failure to make the change within these limits means that the man will go into a coma from which he will never recover. Emphasizing the importance of these safety precautions, the Boeing flight test men have never suffered serious effects from high altitude flying. A doctor is always present, outside the trainer, ready if his services are needed.

New men, not yet ready for an actual Stratotrainer ascent may watch the proceedings through any of four large windows which have been provided in the Stratotrainer. After each man within the trainer has performed the three emergency procedures, the crew is taken to a simulated altitude of 40,000 ft., for the experience, and then the interior of the chamber assumes the pressure conditions of a plane descending.

Upon returning to a ground level atmosphere, the crew members are given a brief medical check to make certain that ears and sinuses have not been adversely affected. Any unusual effects or manifestations are reported to the doctor in charge. Those persons who do not pass the examination in the trainer are given a second opportunity of making a simulated ascent. Regular crew members must retake this examination at frequent periodic intervals to insure proficiency at all times.

### Exit Practice

At the hangar, new crew members must demonstrate that they are intimately conversant with the various emergency exits from the plane. Each crew station has an evacuation exit and an alternate exit. Crew members must demonstrate that they are familiar with the ways of leaving the airplane by all exits.

Having completed this training, they are ready to take their place in a high altitude flight test crew.

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*High altitude flight testing will be described in Part III, the concluding article of this series.*


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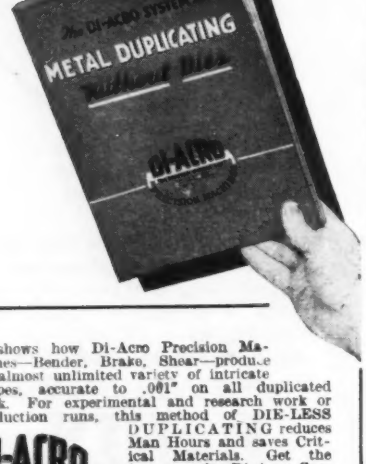


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